SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JULY 1913.

GENERAL PHYSICS.

1107. *Measuring the Flight of Balloons and Flying Machines.* **L. Ambronn.** (Zeitschr. Instrumentenk. 33. pp. 105–107, April, 1913.)—Describes a new instrument for determining the flight of air-craft. The lower part of the apparatus is similar to a theodolite base, and carries a telescope arrangement of special form. The telescope is arranged to look at one of the faces of a total-reflection right-angled prism which is movable about a horizontal axis, and whose position can be noted on a circular scale. A magnetic needle is provided, and special arrangements enable the observer easily to determine the magnetic azimuth, as well as the altitude of the object under observation. A. W.

1108. *Elasticity of Crystals.* **T. Reimers.** (Phys. Zeitschr. 14. pp. 276–278, April 1, 1913.)—According to Voigt (1882), a crystalline rod or cylinder of doubly symmetrical section, when bent, does not undergo a pure flexure, but is also twisted. The author tested this by direct experiment on a rod cut from a gypsum crystal, fixed at one end and loaded at the other by two 1-gm. weights connected by a cocoon fibre lying across the rod. The torsion was observed by means of a small mirror attached to the rod. It was found to be in agreement with Voigt's formula. E. E. F.

1109. *Theory of Elasticity.* **T. v. Kármán.** (Phys. Zeitschr. 14. pp. 253–254, March 15, 1913.)—Maintains, with reference to a paper by H. Lorenz [Abstract No. 540 (1913)], that the theorem according to which "the difference between the internal and double the external work has a singular value in the case of elastic equilibrium" is identical with the principle of minimum potential energy applied to the case of a body obeying Hooke's law. Neither Ritz's method nor Castigliano's theorem need be brought in. **H. Lorenz.** (Ibid. p. 254, March 15, 1913.)—Lorenz replies to the above, agreeing with the derivation of the theorem, but doubting its utility. E. E. F.

1110. *Stress Distribution in Notched Tension Bars.* **E. Preuss.** (Zeitschr. Vereines Deutsch. Ing. 57. pp. 664–667, April 26, 1913.)—The test-pieces were all 75 mm. wide, the load being applied through bolts, 480 mm. apart. A notch was cut at each end of the middle cross-section, various forms being tried. Axial and lateral strains were measured, the principal stresses across the middle section being deduced with the aid of the modulus of elasticity and Poisson's ratio. The axial stresses are shown plotted, and reach sharp maxima at the edges of the notches. For the same depth of notch the max. stress is greater the smaller the radius or base. For constant radius and breadth the max. stress increases with the depth. For semi-circular notches the max. stress increases as the radius diminishes. Neglecting sharp triangular notches, maxima of 1·48 to 2·48 times mean were observed with dimensions each way varying from 5 mm. to 15 mm. The minimum stress at the centre varied from 0·71 to 0·98 of the mean. The stress-distribution is most even over a greater part of the width for wide, shallow notches. It is suggested that the numerical results obtained can be used, *e.g.* to determine the max. bending stress in a shaft at a change of section. The ordinary value of stress $f = MZ$ is replaced by $f = CMZ$, where C is a suitable constant, >1. E. J. S.

1111. *Tests of Three Struts from a Collapsed Gasholder in Hamburg.* **H. Rudeloff.** (Zeitschr. Vereines Deutsch. Ing. 57. pp. 615–620, April 19, 1913.)—The struts were each made up of two steel channels 3290 mm. long, placed back to back, with 26 mm. clear between the webs, a compressive load being applied through 65-mm. balls whose centres were 3465 mm. apart. Lateral movements were detected in two planes at right angles by Bauschinger roller apparatus. Two of the struts exhibited a distinct displacement in the plane of the greatest radius of gyration as well as in that of the least. The increase of bending with load was very uniform, and photographs after crippling show that the member on the tension side is in all cases bent sharply outwards, and the other inwards. It follows that the strength would be increased by placing the channels farther apart. Four Martens mirror extensometers were used to measure the strains on each flange. Although owing to flexure the strains varied greatly from the mean, and the variations were different in the three struts, yet the three means at any given load corresponded remarkably well. This shows that in no case was the metal overstrained at the highest load at which strain measurements were made. Above 40,000 kg. the rate of increase of the mean strain fell off owing to the compressive strains on the tension side changing rapidly to tensile as flexure increased, although on the compressive side they continue to rise faster than the load. The total compressive stress on the strut can, therefore, only be deduced from the mean compressive strain so long as the material is nowhere elastically overstrained. The crippling load is found to be smaller than that given by the usual theorems, the relative values being: Euler 0·76, Tetmayer 0·92. The theory of Müller-Breslau, based on the theory of bending by an eccentric load, all parts being assumed elastic, gives the value 1·006.

E. J. S.

1112. *Hardening Tests.* **G. Charpy.** (Rev. de Métallurgie, 10. pp. 398–399, March, 1913.)—Hardening tests are sometimes specified with a view to determining the utility of a material for a certain purpose (*e.g.* steel for boiler-plates) or to determining whether a material is susceptible to heat treatment. The author discusses the various factors which influence the results of such tests, and points out the necessity that they should be made under definite conditions. F. C. A. H. L.

1113. *Elastic Limit of Alloys.* **A. Portevin.** (Comptes Rendus, 156. pp. 1237–1240, April 21, 1913.)—Experiments have been made on the deformation of pyramidal test-pieces (Fremont method) in order to determine if the elastic limit can be observed microscopically by the appearance of slip bands. In a chemically homogeneous solid solution slip bands first appear in certain grains and gradually extend to the whole of them. By this means it is possible to determine the lower and upper limits of elasticity. In a heterogeneous single solid solution the slip bands first appear in the centre of the grains and do not extend to the edges until higher loads are reached. The result is that the boundaries of the grains are not developed. An alloy consisting of two phases generally develops slip bands only in the α-phase. As a result, therefore, of the mechanical anisotropy of the grains and the chemical heterogeneity of the alloy, the slip bands do not appear simultaneously in all parts of the alloy. Consequently a definite value cannot be ascribed to the elastic limit. F. C. A. H. L.

1114. *Viscosity of Gases.* **H. Piwnikiewicz.** (Phys. Zeitschr. 14. pp. 305–308, April 1, 1913.)—A simplified apparatus is described, consisting of two tubes communicating by a capillary tube 0·4 mm. in internal diam. and 40 cm. long. The gas is expelled from one vessel to the other by mercury against the viscous resistance. A set of glass taps enables one to reverse the current of gas, so that the same gas can be used again. Therein the apparatus differs from that of J. H. T. Roberts [Abstract No. 778 (1912)]. E. E. F.

1115. *Simple Method for determining the Viscosity of Air.* **G. F. C. Searle.** (Cambridge Phil. Soc., Proc. 17. pp. 183–192, April, 1913.)—Air is pumped into a vessel of about 10 litres' capacity until a pressure of 20–25 cm. Hg above the atmosphere is reached, and is then allowed to escape through a capillary tube some 60 or 70 cm. long. The pressure of the air at the beginning and end of a measured interval of time is determined, and from the fall in pressure the volume of air passing is deduced. The viscosity η of the air, in dynes per sq. cm. per unit velocity gradient, is calculated from the formula $\eta = \pi a_0^4 P_0/8lS \,.\, t/\lambda$, where a is the radius of the tube, l its length, P_0 the atmospheric pressure, S the volume of the vessel, t the time, and $\lambda = \log_e [(P_1 - P_0)/(P_2 - P_0) \,.\, (P_2 + P_0)/(P_1 + P_0)]$ where P_1 and P_2 are the pressures at the beginning and end of the interval t. The temperature in the apparatus is considered equal to that of the surrounding atmosphere throughout the experiment. When the flow tube is not of uniform bore, it is necessary to apply a correction, the method for calculating which is given. The mean value obtained for the viscosity of air at 18·8° C. is $1{\cdot}80 \times 10^{-4}$ gm. cm.$^{-1}$ sec.$^{-1}$. W. H. Sr.

1116. *Advance of Alternate Vortices in the Rear of an Obstacle.* **H. Bénard.** (Comptes Rendus, 156. pp. 1225–1228, April 21, 1913.)—In a preceding note [Abstract No. 911 (1913)] the author has localised the zone of formation of alternate vortices. At first the vortices have the same speed as the moving obstacle, but quickly slacken, at the same time diverging to the right and left. They quickly attain their transversal limit, longitudinal equidistance, and limiting speed, which are preserved if the vortices are not too much deadened. When old they are more and more sensible to accidental fluctuations, while the equidistance in particular is less and less well defined. The present paper is a further kinematographic study of the question, numerical data being obtained. H. H. Ho.

1117. *New Species of Cellular Vortices.* **C. Dauzère.** (Comptes Rendus, 156. pp. 218–220, Jan. 20, and pp. 1228–1230, April 21, 1913.)—H. Bénard's work [see preceding Abstract] is briefly referred to, dealing with experiments upon detached vortices. The formation of these is explained by the existence of an extremely thin film covering the regions free from partitions. The case of impure stearic acid such as is found in candles is described, this being coloured rose or blue. The superficial film is formed by very fine grains of colouring matter covering the whole surface, so that isolated vortices are no longer formed. Thermal convection gives rise beneath the film to elongated vortices analogous to some observed by Bénard. The free surface is formed of longitudinal furrows comprising parallel and equidistant crests and troughs, relieved at certain points by transverse division, which sometimes gives an hexagonal cellular network, often, however, only in a state of outline. In consequence of this relief there is the formation of distinct focal lines when observed by refracted light. The description is illustrated by four photographs. The experiments were performed at rising and falling temperatures, results for varying thicknesses of liquid being given. H. H. Ho.

1118. *Co-ordinate Systems of Dynamics.* **E. Gehrcke.** (Deutsch. Phys. Gesell., Verh. 15. 7. pp. 260–266, April 15, 1913.)—Discusses the co-ordinate systems from the standpoint of the classical mechanics and the modern theory of relativity. E. H. B.

1119. *Minkowski's Mechanics.* **F. J. de Wisniewski.** (Ann. d. Physik, 40. 4. pp. 668–676, April 15, 1913.)—The second part of a mathematical treatment. [See Abstract No. 763 (1913).] E. H. B.

1120. *Measurement of the True Static Pressure in a Moving Fluid Application to an Aeroplane Barograph.* **A. F. Zahm.** (Frank. Inst., Journ. 175. pp. 503–509, May, 1913.)—Briefly discusses the errors of a barograph carried on an aeroplane caused by the rush of air past the instrument case. L. H. W.

1121. *Hurricanes of the West Indies.* **O. L. Fassig.** (U.S. Department of Agriculture, Weather Bureau, Bull. 10. pp. 7–28, March, 1913.)—In addition to a detailed discussion of the West Indian hurricanes the paper deals with the cyclones of the Bay of Bengal and the typhoons of the Western Pacific, these all being of the same type of revolving storm. In 1899 a chain of cable reporting stations was established along the margin of the hurricane region, and all well-developed storms occurring within the area have since been carefully reported and charted from day to day. A detailed account is given of the movements of a destructive storm which passed over the district during the period Aug. 7–20, 1899. The pressure recorded in the centre of this hurricane was 27·75 in. In tropical storms in general there is a moderate decrease of pressure to within 40 or 50 miles of the centre and then the rapid fall which is associated with the destructive winds. 90 % of all the hurricanes recorded have their origin within a belt extending from 56° to 90° W. longitude and from 12° to 26° N. latitude. The normal track for the entire season, determined from 135 storm paths, extends in a W. by N. direction between 18° and 20° N. to the centre of the hurricane area (20° N., 78° W.) then NW. and N., recurving over central Florida. The trend is then NE.

over the North Atlantic. The normal track differs from month to month. Its movements coincide very closely with those of the trades and equatorial belt of calms. The hurricane season is of short duration, 88 % of all hurricanes occurring in the period Aug.–Oct. The mean rate of travel of these storms is 300 miles per day, or less than half the speed of the temperate-region cyclone of the United States. The average duration of a hurricane is 6 days. The signs of an approaching storm are discussed in detail, the most important and earliest sign being the cirrus cloud.

J. S. Di.

1122. *On the Occurrence of Line Squalls in relation to the March of the Barometer at a Place.* **Durand-Gréville.** (Comptes Rendus, 156. pp. 1190–1193, April 14, 1913.)—A barogram obtained at any station may be constructed from the corresponding isobaric map by drawing a section through the station across the map, parallel to the direction of propagation of the isobaric distribution, if it is assumed that the form and intensity of the distribution does not change. By considering sections across a typical depression with a *ruban de grain* (line squall) arranged along a radius on its southern side, it is shown that the form and position of the *crochet barometrique,* indicated on the barogram as representing the pressure-increase connected with the squall, depends at each instant upon the angle which the direction of the *ruban* makes with the direction of motion of the centre of the depression.

R. C.

1123. *Relation between Atmospheric Absorption and Polarisation of Light diffused by the Sky.* **A. Boutaric.** (Comptes Rendus, 156. pp. 1289–1292, April 21, 1913.)—Observations at Montpellier, made as frequently as the state of the sky permitted, of (1) the proportion of polarised light contained in the light diffused by the sky, and (2) heat radiation at different times of the day, measured by an Ångström pyrheliometer, lead to the conclusion that for the greater part of the radiation from the sun, the absorption by the atmosphere varies inversely with the proportion of polarised light. R. C.

LIGHT.

1124. *Soleil-Babinet Compensator with Half-shadow Arrangement.* **G. Szivessy.** (Deutsch. Phys. Gesell., Verh. 15. 6. pp. 201–209, March 30, 1913.)—Describes, and also gives theory of, a half-shadow compensator which consists of an ordinary Soleil-Babinet compensator provided with a half-shadow plate. The arrangement permits of considerably increased accuracy of adjustment. A sensitive modification is obtained as follows:—The half-shadow plate is fixed, the optic axes of the two halves H_1H_2 being parallel to the face of the plate and respectively parallel and perpendicular to the line of separation of the two halves. The fixed wedge and also the movable one are similarly divided: the halves $W_1W'_1$, through which the light passes after going through H_1, have their optic axes parallel to the face of the half-shadow plate and perpendicular to the line of separation; in the other halves $W_2W'_2$ the axes are parallel to the line of separation. A. W.

1125. *New Microscope Eyepieces.* **Metz.** (Zeitschr. wiss. Mikroskopie, 29. p. 72. Nature, 91. pp. 59–61, March 20, 1913.)—The author has recently described a micrometer in which the scale used is such that microns can at once be read off without greatly changing the tube-length, or considering the micrometer value of the objective employed. The intervals of the new scale, instead of being 1/10 or 1/20 mm. wide, as is usually the case in eyepiece micrometers, have a definite value of 0·06 mm. With a 2-mm. ($\frac{1}{12}$ in.) objective, when a stage micrometer with ten 1/100 mm. divisions is viewed, each of these divisions falls on the larger divisions of the eyepiece micrometer. Each of the smaller divisions therefore represents a micron. With a 4-mm. ($\frac{1}{6}$ in.) objective the ten divisions of the stage micrometer cover five of the large divisions of the eyepiece micrometer; hence to obtain microns we must multiply by 2, and this is all the arithmetic needed. In the new micrometer the intervals are arranged in groups or steps of ten, each group being indicated by a black echelon rising from the first to the tenth interval, thus making it easy to read. The apparatus is made by Leitz. Another form of eyepiece, also introduced by Leitz, enables two observers to use the same objective. It is called a double demonstrating eyepiece, since it is designed for demonstrating purposes. The field of view is common to both eyepieces, and contains a pointer which either observer can direct upon any feature to which he wishes to direct attention. A sketch of the apparatus is given. A. W.

1126. *New Mounting for Microscope Preparations.* **C. Cépède.** (Comptes Rendus, 156. pp. 683–685, March 3, 1913.)—Describes a new method of mounting microscope preparations, which allows both faces of the object to be studied at the highest magnifications. Ordinary plates are perforated with a circular hole in the central part 19 mm. diam. The lower edge of the hole is slightly countersunk, and the upper edge is countersunk so as to leave a ledge, the diam. of the countersunk part being 23 mm. A cover-glass 22 mm. diam. is secured in the recess, the object mounted on it in balsam or gelatine, and another cover-glass pressed lightly on the top. The balsam or gelatine serves as a cement to unite the cover-glasses to the plate, which is dried in the ordinary way. One advantage of this method of mounting is that a number of such plates can be packed in contact, with no risk of damaging special specimens by the pressure of one plate against another, since a considerable space separates the face of the cover-slips from the face of the plate. A. W.

1127. *Imprisonment of Radiation by Total Reflection.* **R. W. Wood.** (Phil. Mag. 25. pp. 449–452, April, 1913. Phys. Zeitschr. 14. pp. 270–272, April 1, 1913.)—In working with his rhodamine fluorescent reflectors for the mercury arc, P. Cooper Hewitt found that if the celluloid film stained with rhodamine was backed by white paper the fluorescence was many times brighter than when a backing of silver paper was used. This result has been verified by Wood by depositing silver chemically over a very small circular area in the centre of a white porcelain plate, and flowing the whole with the rhodamine solution, or with water containing a little fluorescein. Notwithstanding the very high reflecting power of the polished silver film, the intensity of the fluorescence over the circular area was so feeble that it appeared almost black in contrast with the brilliant fluorescence over the surface of the porcelain. The plate was illuminated with the mercury arc in the case of the rhodamine, or with the light of the carbon arc, passed through dense cobalt glass, in the case of the fluorescein. It was noticed that the films which had been stripped from the surface glowed brilliantly along the edges, this being due to the circumstance that more radiation was able to escape here than through an equal area of the surface of the film. The action of the matt surface is to liberate the energy imprisoned by internal reflection. Mendenhall has found that with a scratch on the surface of a ball of fused quartz, heated in a Bunsen burner, the black-body temperature of the scratch, as observed with an optical pyrometer, was 850° C., while that of the rest of the ball was barely 600° C. From various considerations he concludes that a uniformly heated, nearly transparent sphere should appear more luminous towards the limb. This has been verified by Wood, using a hollow glass bulb filled with a very dilute solution of rhodamine, illuminated by the mercury arc and viewed through red glass. If a spot on the surface of the bulb is finely ground with flour emery, this spot appears extremely luminous when near the limb, as a result of the liberation of the fluorescent rays which are undergoing total internal reflection. A. W.

1128. *Fluor-crown Glass.* **E. Zschimmer.** (Zeitschr. Instrumentenk. 33. pp. 145–148, May, 1913. Communication from the Optical Works of Messrs. Schott, Jena.)—Describes a new kind of glass for optical purposes, the index of refraction being very low. Three types are made, the optical properties of which are shown in the following table :—

Type.	Refractive Index n_D.	Mean Dispersion $(n_F - n_C)$.	$\nu = \frac{n_D - 1}{n_F - n_C}$	Specific Gravity.
O 6781	1·4933	0·00706	69·9	2·48
O 6500	1·4710	0·00701	67·2	2·31
O 7185	1·4637	0·00707	65·6	2·27

A. W.

1129. *Some Transformations in Formulæ for Refraction and Polarisation, and determination of the Pressure of Light.* **A. G. Rossi.** (Accad. Sci.

Torino, Atti, 48. 4. and 5. pp. 209–255, 1912–1913.)—It is shown how by considering the ratio of the tangents, rather than of the sines, of the angles of incidence and refraction, a magnitude is obtained which has notable physical significance, being equal to n^2 for the Brewsterian incidence, and being also the factor by which it is necessary to multiply the square of the refracted amplitude in order to obtain the intensity. Denoting the ratio of the tangents by X, the author deduces many new relations by substituting it in various well-established formulæ. Experiments are also described on the measurement of the pressure of light, employing a slight modification of the apparatus devised by Amerio [Abstract No. 588 (1910)]. W. H. Si.

1130. *Refraction and Dispersion of Gaseous Compounds.* **C. Cuthbertson.** (Phil. Mag. 25. pp. 592–604, April, 1913.)—The experimental results are shown in a table in the original, and the concurrent changes in absorption, so far as they are known, may be summarised as follows :—A. (1) In hydrochloric, hydrobromic, hydriodic acids, hydrogen disulphide, and sulphur dioxide, the refractivity of the compound is less than the sum of the refractivities of its constituents, and the dispersive power of the compound lies between those of its constituents. (2) In the spectra of chlorine, bromine, iodine, and sulphur, strong absorption bands occur in the violet and near ultra-violet, which disappear in the compound. B. (1) In nitrous oxide, nitric oxide, ammonia, and ozone, the refractivity of the compound is greater than the sum of the refractivities of the constituents, and the dispersive power is greater than that of either constituent. (2) In the spectra of nitrous oxide, nitric oxide, and ozone, absorption bands appear in the ultra-violet which are not present in the spectra of the elements. To explain these results the author puts forward an hypothesis which is then discussed. L. H. W.

1131. *Electric Double Refraction.* **C. Gutton.** (Comptes Rendus, 156. pp. 387–389, Feb. 3, 1913. Journ. de Physique, 3. Ser. 5. pp. 206–217, March, 1913.)—The experiments of Blondlot, Abraham and Lemoine, James [Abstract No. 797 (1905)] and the author, have shown that the electric double refraction of CS_2 has completely disappeared a very short time after the suppression of the electric field. The lag, if it exists, does not exceed the time during which light travels 0·5 m.; and nothing else tends to establish the existence of a lag. The experiments described in the present paper lead to the conclusion that, in a field of variable intensity, the variations of the electric double refraction do not follow exactly the variations of the field. Between a polariser and analyser at extinction, with polarisation planes at 45° to the horizontal, are placed, one behind the other, two condensers ; they are immersed in different liquids whose electric double refractions have the same sign. The plates are connected two by two to the terminals of a Holtz machine, so that the two condensers are always charged to the same p.d. The lines of force are horizontal between the plates of the first condenser and vertical between those of the second ; and so the condensers produce, between the two components of the light polarised vertically and horizontally, path-differences of opposite signs. The two effects can be made exactly to compensate each other by altering the distance between the plates of one of the condensers. After this compensation has been effected the condensers are connected to an oscillator giving intense Hertzian waves of half wave-length 2·2 m. If the double refraction followed instantaneously the variations of the field the compensation made for static charges would still hold, but it is found necessary to reduce the distance apart of the plates of one condenser by 1/26 of the total distance (2·1 mm.) in order to secure extinction again. Hence it is concluded that the electric double refraction does not follow instantaneously the variations of the electric field. The liquids used were naphthaline bromide, and, in the variable condenser, carbon disulphide. Other liquids used were benzene, toluene, chloroform, and nitrobenzene. Chloroform has, according to Schmidt, a Kerr constant equal to that of carbon disulphide but of opposite sign. It was found possible to obtain compensation with these liquids, using two condensers with parallel plates. Passing from static to oscillatory charges, extinction was obtained again by increasing slightly (about 1/200) the thickness of the carbon disulphide condenser. The results of these experiments can be explained by the theory of molecular orientation developed by Langevin. The magnitude of the Kerr constant seems to play the greater part in determining the duration of the establishment of electric double refraction; viscosity does not appear to be important. [See also Abstracts Nos. 380, 1020 (1912).] A. W.

1132. *Deviations produced by Prisms.* **H. S. Uhler.** (Amer. Journ. Sci. 35. pp. 389–423, April, 1913.)—The problem of prismatic deviation is treated mathematically in this paper in a complete and thorough manner. The discussion has reference to the case of a single prism with unlimited plane faces, and surrounded by one medium whose absolute index of refraction is less than the absolute index of the material of the prism. A. W.

1133. *Scattering and Absorption of Light in Gaseous Media, with applications to the Intensity of Sky Radiation.* **L. V. King.** (Roy. Soc., Phil. Trans. 212. pp. 375–433, Feb. 8, 1913. Roy. Soc., Proc. Ser. A. 88. pp. 83–89, Feb. 24, 1913. Abstract.)—The author divides his paper into three sections: Part I. containing a general theoretical discussion, Part II. applications to the earth's atmosphere, and Part III. analysis of observations on absorption and scattering, with numerical tables and diagrams illustrating attenuation of sunlight and intensities of sky radiation. In Part I. the scattering of parallel radiation by molecules and small particles is first dealt with. Rayleigh first worked out the effect of small particles in scattering incident radiation, finding that when a stream of parallel radiation falls on a particle whose dimensions are small compared with the wave-length, the resulting secondary disturbance travels in all directions at the expense of the intensity in the original direction. Later Rayleigh gave reasons for believing that the molecules of a gas are themselves able to scatter radiation in this way. In a gaseous medium it is legitimate to sum up the intensities of the scattered radiation due to each molecule in an element of volume, without a consideration of phase-difference in consequence of the continuous change in the relative positions of a molecule in a gas. The same applies to the case where the scattering is due to small particles of dust, since these partake, to some extent, of the molecular agitation of the gas in which they are held in suspension. If E be the intensity of unpolarised radiation falling on a gas of density ρ and containing N molecules per unit volume, then the results of Kelvin and Rayleigh worked out on various hypotheses of the molecule and of the æther agree in giving rise to the expression, $\mu(\theta) = \frac{1}{2}\pi^2(n^2-1)^2\lambda^{-4}(1+\cos^2\theta)E/N$, where n is the refractive index, λ the wave-length of the incident radiation, and θ the angle which the scattered radiation makes with the incident. This result has been obtained by Schuster from general considerations independent of any particular theory. The intensity of the scattered radition is therefore twice as great in the direction of the incident radiation as it is in a direction at right angles. The effect of scattering is then shown to diminish the intensity of the incident radiation, giving rise to the phenomenon of attenuation especially noticeable in the diminution of intensity of solar radiation in its passage through the earth's atmosphere. A term is then introduced expressing the fact that the temperature at any point is increasing, in order to give greater generality to the analysis. The general integral equation for the scattered radiation is next deduced, and the analogy to the ordinary procedure of potential theory noted. For solving the general equation a number of simplifying assumptions are necessary, and these are considered in Part II., where the particular problem of the earth's atmosphere is taken up. The assumption is made that the earth's surface is a plane, and that the density is a function of the height above the earth's surface only, effects due to reflection from the earth's surface and refraction by the earth's atmosphere being also neglected. Expressions are then obtained, and, by a series of further assumptions, it is shown that the problem of scattered radiation in the earth's atmosphere reduces to the case of an atmosphere of uniform density contained between two parallel planes, the transformation employed being independent of any law of density with height, provided the planes of equal density are parallel to the earth's surface. Approximate solutions of integral equations are then discussed, and the solution for sky radiation given. The question of the polarisation of sky radiation is next considered. It is well known that the latter is partly polarised in a vertical plane passing through the position of the sun, and so far as the radiation to be scattered is direct solar radiation the polarisation ought to be complete. That portion of the sky radiation due to self-illumination is largely unpolarised, and may to a large extent account for this deficiency from complete polarisation. The analysis of the present paper enables the magnitude of this factor to be roughly estimated, where in default of a rigorous solution the reasonable supposition is made that the portion of the scattered radiation due to self-illumination is independent of the polarisation angle of the incident radiation.

Part III. contains the analysis of observations made on the attenuation of solar radiation by the earth's atmosphere. The cases of long- and short-wave radiation are separately dealt with, and the fact pointed out that the analytical method employed offers a convenient way of studying variations in the distribution of atmospheric dust and their connection with other meteorological phenomena. The intensity of sky radiation as calculated from the mean coefficients of attenuation at Mount Wilson and Washington is then examined. The present paper appears to support the view that at levels above Mount Wilson molecular scattering is sufficient to account completely both for attenuation of solar radiation and for the intensity and quality of sky radiation. Even at sea-level, the effect of atmospheric dust can be taken into account in a simple manner in the formulæ for absorption and scattering. The hope is expressed that should future observations support the validity of the simple formula connecting the coefficient of attenuation with the wave-length, then the coefficients for very short or very long wave-lengths may be obtained when the direct method of calculation from high and low sun observations leaves room for considerable uncertainty, owing to the small intensities in the solar spectrum at these wave-lengths and to other experimental difficulties. Thirteen exhaustive numerical tables are appended, giving comparisons of theory with observation, accompanied by explanatory diagrams. H. H. Ho.

1134. *Propagation of Light in Non-homogeneous Media.* **K. Försterling.** (Phys. Zeitschr. 14. pp. 265–270, April 1, 1913.)—Adapts the electromagnetic equations to the case of a variable dielectric constant. Assuming that the variation is small and confined to one axis, the author works out a theory of the propagation of light, and shows that it covers the bulk of the phenomena observed in Lippmann's colour photography. E. E. F.

1135. *Separation of Luminous and Heating effects of a Source of Light.* **Dussaud.** (Comptes Rendus, 156. p. 948, March 25, 1913.)—For concentrating the light of a given source a group of optic systems is used, one succeeding the other automatically and each system taking a definite position for a certain interval of time. The heat absorbed by the system while the light is passing through it is lost by radiation, etc., while the system is out of action. This arrangement permits the source to be placed much nearer the condensing system than ordinarily is the case, and so the focal length of the system may be made half that which would be required for the same system if fixed. The light issuing from the condensing system is found to have little heating power. [See also Abstract No. 804B (1912).] A. W.

1136. *Power of "Solution" of Photographic Plates.* **E. G. Goldberg.** (Zeitschr. wiss. Phot. 12. pp. 77–92, April, 1913.)—The ability of photographic plates to define objects, such as lines when separated by minute distances, has been the subject of various researches, among the more recent being those of Mees and Scheffer. The method adopted to test the degree of definition by means of circular apertures is fully described in the present paper. Photographic illustrations of the results obtained, and also curves showing the connections between the various factors involved, are given. The practical outcome is considered at some length. The general results are as follows:—It is not possible to determine the ability of a plate to reproduce finer details by taking account of the so-called "Power of Solution" only. Two properties quite independent of each other must be separately considered: the relation between the increase in width of the image of a copied disc and the lighting (Trübungsfaktor), and the limit of "solution"; the latter probably depends on the degree of difference in light sensitivity of the single grains of the emulsion. Methods of determining these factors are elaborated. A. E. G.

1137. *Measurement by Means of Registering Microphotometers of the Blackening Distribution in Wedge Slit Photographs obtained with Röntgen Rays.* **P. P. Koch.** (Ann. d. Physik, 40. 4. pp. 797–811, April 15, 1913.)—A modified form of Hartmann's microphotometer has been previously described [Abstract No. 1522 (1912)]; the instrument has also been used for taking measurements of slit photographs obtained by Walter and Pohl [Abstract No. 1224 (1909)]. It is important that the results obtained by this means should be verified by another method, on account of the light they throw upon the nature of Röntgen rays and the determination of their wavelength. It is now shown that an independent method giving results in good agreement can be applied, but it is suggested that the suitability of the photographic plates for such measurement should be made the subject of research. A. E. G.

1138. *Flare-spots in Photography.* **G. F. C. Searle.** (Cambridge Phil. Soc., Proc. 17. pp. 205–219, April, 1913.)—Rays of light that have been twice reflected within a lens system (such as a photographic lens) may give rise to *ghosts* and *flare-spots.* Experiments are described with spectacle lenses illustrating these phenomena. Theory is given. A. W.

1139. *Photometry of Photographic Negatives.* **G. Neumann.** (Phys. Zeitschr. 14. pp. 241–245, March 15, 1913.)—Describes a simple arrangement adapted to any optical bench. Uses a Lummer-Brodhun cube, and plaster plates illuminated by two slits closed by ground-glass plates. The illumination is by a Nernst lamp, as the light is somewhat feeble. Observation is made through a telescope magnifying three times. E. E. F.

1140. *Rainbows.* **W. Möbius.** (Ann. d. Physik, 40. 4. pp. 736–747, April 15, 1913. Extract from Preisschrift. d. Fürstlich Jablonowsk. Gesell., Leipzig, No. 42. pp. 1–31, 1912.)—A mathematical treatment of the theory of rainbows formed at spheres of diams. from one to ten wave-lengths of the light. The paper is illustrated by a number of graphs showing the fluctuations of the functions concerned. [See Abstracts Nos. 258 (1909) and 1723 (1910).] E. H. B.

1141. *New Mirror Stereoscope.* **C. Pulfrich.** (Zeitschr. Instrumentenk. 32. pp. 337–347, Nov., and pp. 365–371, Dec., 1912. Communication from the Optical Works of C. Zeiss, Jena.)—Deals at length with the special form of prism required, having the largest possible picture angle. L. H. W.

1142. *New Spectrophotometer with Savart's Polariscope.* **M. Wagner.** (Zeitschr. Instrumentenk. 33. pp. 149–152, May, 1913.)—Describes, with diagram, the construction of a spectrophotometer similar in principle to the apparatus used by Umow. [Abstracts Nos. 2043 (1909) and 169 (1913).] A. W.

1143. *A Graphic Method of Optical Imagery.* **W. R. Bower.** (Phys. Soc., Proc. 25. pp. 160–177, April, 1913.)—A development of optical imagery based on elementary geometry, including limiting positions, but excluding cross-ratios, centres of perspective, etc. L. H. W.

1144. *Illumination and Eyestrain.* **E. M. Alger.** (Amer. Illum. Engin. Soc., Trans. 8. pp. 130–137; Discussion, pp. 138–143, March, 1913.)

1145. *Corrections in a Newton's-rings System.* **A. Ferguson.** (Phil. Mag. 25. pp. 501–506, April, 1913.)

1146. *Fringes of Crystalline Plates with Parallel Faces.* **C. Raveau.** (Comptes Rendus, 155. pp. 965–968, Nov. 11, 1912.)

1147. *Absorption of Ultra-violet Light by Acetylene.* **V. Henri** and **M. Landau.** (Comptes Rendus, 156. pp. 697–699, March 3, 1913.)—A study was made of the absorption by the gases CH_4, C_2H_6, C_2H_4, C_2H_2, CO, and CO_2. Instead of using as the source of light a condensed spark between Al electrodes in water, which necessitates long exposures on account of the feeble luminosity of the spark, the authors employed a high-frequency spark between Al electrodes in water, thereby obtaining a very luminous continuous spectrum in the whole ultra-violet region as far as λ2150, the exposures necessary being only from 30 secs. to 3 mins. The results given are only for pure acetylene (i) gaseous at ordinary temperature and pressures from 1 to 0·1 atmo., (ii) in alcoholic solution. The ultra-violet absorption spectrum of gaseous acetylene is fluted and possesses a great number of bands, from λ3157 to λ2236·4. These bands are more or less sharp according to position. Many of them examined at high magnification are resolved into series of very fine bands, less than 1 Å. apart. Three groups of bands are distinguished. The first, and sharpest group, extends from λ3157 to λ2880 ; they have sharp edges on the ultra-violet side and are shaded off towards the red. The frequency-difference Δ*n* of the heads of the bands is constant, the mean value of Δ*n* being 23. Towards λ2960 a second set of bands begins to appear between the bands of the first group, and between λ2800 and λ2500 there are a great number of bands, some with sharp edges on the ultra-violet side, others with diffuse edges. They have not been classified. Between λ2500 and λ2327·5 gaseous acetylene at a thickness of 40 cm. shows no appreciable absorption. A third group begins about λ2327·5 and extends to λ2236·4 ; they have sharp edges on the ultra-violet side, are resolvable into series of extremely fine bands, and the frequency-differences of the heads of the bands increase in a regular manner. Alcoholic solutions of acetylene show a single very large absorption band commencing about λ2850 and having a maximum about λ2631. It is interesting to note that the absorption of ultra-violet light by acetylene and, as will be shown later, by the other carbides of hydrogen, commences about the region where the ultra-violet solar spectrum terminates. This fact could serve as the basis of a supposition of the presence of carbides of hydrogen in the solar atmosphere. [See also Abstract No. 980 (1913).] A. W.

1148. *Satellites of the Mercury Lines.* **R. W. Wood.** (Phil. Mag. 25. pp. 443–449, April, 1913. Phys. Zeitschr. 14. pp. 273–275, April 1, 1913.)—A plane grating arrangement of 42 ft. vocal length was used to study the structure of the mercury lines 5769, 5790, 5461, and 4359. The grating had high resolving power, about that of a large echelon. Photographs are reproduced of the lines with their satellites, and the results are discussed with reference to those previously obtained by other investigators. A. W.

1149. *Distribution of Emission in the Arc between Metal Rods.* **H. Könemann.** (Zeitschr. wiss. Phot. 12. pp. 65–76, April, and pp. 123–142, May, 1913.)—The arc spectra of a series of metals—Sn, Zn, Pb, Ca, Tl, Cd, Mg, Al, Cu, Ag—were obtained with a quartz spectrograph, and the distribution of the emission was investigated in the region from λ4000 to λ2000. The appearance of spark lines in the arc, up to the present known only in certain cases, is shown to be a general property of the arc spectrum. Between the two poles of the arc a number of lines are shown to have uniform intensity ; other lines are stronger at both poles, while others again are found only at the negative pole or at the positive pole, or at both. Also in the same spectrum sometimes one, sometimes the other pole shows increased intensity. Among the lines which show no increased intensity at the poles are many arc lines. Lines which show the greatest difference, or appear only at the poles, are the spark lines known as enhanced lines. The author's results are in agreement with those of other workers as regards a large number of the "pole" lines, but not for all lines showing increased intensity. The majority of the lines strengthened at the poles are found in the extreme ultra-violet. The intensity ratio of the spark lines in the arc is different from that of the enhanced lines in the spark. Different groups of enhanced lines were investigated. The appearance of the spark lines in the neighbourhood of the pole explains the difference of the ultra-violet spectra with long and short arcs, observed by many investigators. The spectral behaviour is compared with the thermal, chemical, and electrical properties of the corresponding element : a definite relation could not be established. A discussion of the causes giving rise to differences of spectra leads to the conclusion that neither temperature distribution alone, nor distribution of potential gradient alone, nor other conditions alone can explain the appearance of the spark lines. A. W.

1150. *Remarks on Vegard's Researches.* **J. Stark.** (Ann. d. Physik, 40. 4. p. 735, April 15, 1913.)—Stark adheres to the explanation previously given by him [see Abstract No. 601 (1913)] rather than to that put forward by Vegard. The complicated nature of the methods employed renders it practically impossible to decide between the two hypotheses, and, further, the dispersion obtained with the spectrographs used was insufficient. On this account further observations with instruments of greater dispersion are being carried out on the intensity distribution in the canal-ray spectrum. A. E. G.

1151. *Zeeman-effect.* **A. Sommerfeld.** (Ann. d. Physik, 40. 4. pp. 748–774, April 15, 1913.)—The author explains the recent results of Paschen and Back [see Abstract No. 419 (1913)] by a modification of the elementary Lorentz theory: instead of the field of quasi-elastic force which binds the electron to its equilibrium position being isotropic, it is assumed to be æolotropic. If the three resulting frequencies are nearly equal, we have a close triplet-doublet, special of two equal frequencies. For small fields, *i.e.* $(e/m)\,H < \Delta n$ (Δn greatest of the three frequency-differences n_1-n_2, n_2-n_3, n_3-n_1), the triplet expands proportionally into H^2. For large fields, *i.e.* $(e/m)\,H > \Delta n$, the electron behaves asymptotically as an isotropic electron, that is, it gives normal triplet and separation proportional to H. J. M.

1152. *Photoelectric Investigation of Fluorescent Substances.* **W. E. Pauli.** (Ann. d. Physik, 40. 4. pp. 677–700, April 15, 1913.)—A series of fluorescent substances was investigated with regard to their photo-electric behaviour when illuminated with ultra-violet light. A set of suitable substances was also dealt with, using light from the visible spectrum. A photo-electric effect was found with all such substances first with an illumination whose max. wave-length was 420 $\mu\mu$. The effect found when using ultra-violet light for illumination was on the average very small, being from 1/100 to 1/500 of the effect obtained with zinc. With the substances for which light in the visible spectrum was used the susceptibility-distribution of the fluorescence was investigated by a new method. No connection was found between the photo-electric effect and the susceptibility-distribution. The results are utilised as basis for theory. It appears probable that there is a difference of structure between molecules possessing fluorescent and those possessing phosphorescent properties. A. W.

1153. *Interference Phenomena with Röntgen Rays.* **W. Friedrich, P. Knipping, and M. Laue.** (K. Bayer. Akad. München, Ber. pp. 303–322, 1912. Le Radium, 10. pp. 47–57, Feb., 1913.)—According to generally accepted theory, the atoms in crystals are arranged in a regular manner as regards spacing throughout the whole of the crystal. Therefore if X-rays fall on a crystal, interference effects ought to be observed if the X-rays are similar to light-waves of very short wave-length. In the experiments described a narrow pencil of X-rays fell on a crystal having a photographic plate placed behind it and normal to the beam. Exposures of many hours were made, and on development it was found that, in addition to the central image caused by the main beam, regularly arranged spots were present on the plate. With powdered $CuSO_4$, for example, no such effects were observed.

The effects were found with crystals of $CuSO_4$, rock-salt, diamond, and zinc blende. With the plate of the latter (a cubic crystal) 1·0 × 1·0 × 0·05 cm., cut parallel to one of its principal axes, an extended series of photographs were made with the crystal orientated at different angles. A theoretical examination of the position of the spots in the various photographs is given by the last-named author, the crystal being treated as a three-dimensional diffraction grating and the spots as due to the reinforcement of the waves in different directions. The calculated positions of the spots are in good agreement with theory, it being also assumed that definite wave-lengths are present, presumably corresponding to the characteristic X-radiations from the zinc and the sulphur. Five definite wave-lengths are given, varying between 1·27 and $4{\cdot}83 \times 10^{-9}$ cm. E. M.

1154. *Multiple Images by Röntgen Rays after Traversing a Crystal.* **M. de Broglie.** (Comptes Rendus, 156. pp. 1011–1012, March 31, 1913.)—Using practically the same arrangement as Friedrich, Knipping, and Laue [see preceding Abstract], the present author has tried rock-salt immersed in liquid nitrogen, rock-salt in a transverse magnetic field of 10,000 units; he has also examined blende, fluorine, and magnetite without discovering any marked departures from the original phenomena. E. H. B.

1155. *Reflection of Röntgen Rays.* **M. de Broglie.** (Comptes Rendus, 156. pp. 1153–1155, April 14, 1913.)—An experimental study of the reflection of X-rays from rock-salt and magnetite, with six photographic reproductions of the results obtained. The various reflected images occur in a ring form. It is asserted that bands were obtained in some of them. The reflection was obtained from bismuth also, but not from flint-glass. [See preceding Abstract.] E. H. B.

1156. *Reflection of X-Rays.* **M. de Broglie.** (Nature, 91. pp. 161–162, April 17, 1913.)—The paper contains interesting diagrams of the distribution of the pencils of X-rays due to the scattering of a very narrow beam by various crystals. The author considers that the transmitted "spots" of Friedrich, Knipping, and Laue are due to the same cause as the reflected spots obtained by allowing a beam of X-rays to fall on a face of a crystal at almost grazing incidence. The results show that the spots produced on a photographic plate by the pencils scattered from the crystal are generally striated by parallel fringes both in the case of reflected spots and transmitted spots. Similar phenomena are obtained with ordinary light and two ordinary (200 lines to the mm.) gratings when the incident beam forms similar angles of incidence with the plane of the gratings. E. M.

1157. *Interference of Röntgen Rays.* **G. Wulff.** (Phys. Zeitschr. 14. pp. 217–220, March 15, 1913.)—Develops Laue's theory of the diffraction patterns obtained on transmitting X-rays through a crystal [Abstract No. 1153 (1913)], in which the crystal is regarded as a three-dimensional grating. Every position of the crystal produces a distinct interference pattern, and a displacement of a very few degrees may alter the type of pattern entirely. It may always, however, be brought into relation with the crystalline structure. E. E. F.

1158. *Reflection of Röntgen Rays.* **L. Mandelstam** and **H. Rohmann.** (Phys. Zeitschr. 14. pp. 220–222, March 15, 1913.)—The "reflection" of

X-rays by mica is intensified by a cleavage of the crystal. Reflection is strongest where the cleavage is apparent, but it is also strengthened for some distance round the cleavage patch. The authors believe that the "interference" patterns found are largely due to reflection from cleavage planes within the crystal, whether the cleavage is apparent or not. E. E. F.

1159. *X-Ray Spectra.* **E. A. Owen** and **G. G. Blake.** (Nature, 91. p. 185, April 10, 1913.)—A beam of rays from a Röntgen bulb was directed through a slit on to the cleavage surface of a crystal of selenite at almost grazing incidence, the beam being made practically parallel by means of suitable lead stops. The photographs taken of the reflected beam all show exceedingly well-defined lines, which are not equally spaced, their number and distances apart varying according to the particular bulb used. These lines are parallel to each other and to the slit. The hardness of the bulb affects the relative intensity of the lines, but apparently makes no difference to their relative positions, the results suggesting that the rays of longer wave-length are less deviated than those of shorter wave-length. The results further suggest that the lines obtained may be spectral lines in the spectra of the beams emitted from the respective bulbs. E. M.

1160. *X-Rays and Crystals.* **T. Terada.** (Nature, 91. pp. 185–186, April 10, and p. 213, May 1, 1913.)—Repeating the experiments of Friedrich, Knipping, and Laue [Abstract No. 1153 (1913)] on the transmission of X-rays through crystals, the author finds that the transmitted rays may easily be made visible on an ordinary fluorescent screen when a sufficiently large and intense pencil is used. The X-ray tube used was a Müller-tube of 20 cm. diam. with water-cooling, the current being supplied by a Toepler influence machine. The diam. of the pencil of rays was 0·5 to 1·0 cm. The crystals examined were borax, alum, mica fluorspar, rock-salt, rock-crystal, cane-sugar, etc. The transmitted rays showed numerous detached fluorescent spots of elongated shape. If the crystal is rotated about an axis perpendicular to the incident ray, the spots move generally across the central spot caused by the main beam, but the axis of rotation may be chosen so that some of the spots remain stationary while the crystal is rotated. Groups of detached pencils appeared to be arranged on circular cones touching the incident pencil, the aperture of the cones varying continuously with the inclination of the crystal. The results of the observations are favourable to the explanation suggested by W. L. Bragg, that planes in the crystals rich in molecules or atoms behave as reflecting planes for rays at grazing incidence [see Abstract No. 604 (1913)]. E. M.

1161. *Diffraction Patterns from Crystals.* **H. S. Allen.** (Nature, 91. p. 268, May 15, 1913.)—A cylindrical pencil of light of very small cross-section was allowed to fall upon a crystal of selenite or phlogopite with a photographic plate placed about 20 cm. behind the crystal. The resultant image often showed lines or streaks radiating from the centre at angles depending on the crystal and its orientation. **Tutton** (Ibid.) considers the streaks in the photographs as due to "asterism" caused by fine enclosures arranged along the glide planes, and parallel to the cleavage plane. E. M.

1162. *Reflected X-Rays.* **E. Hupka.** (Nature, 91. p. 267, May 15, 1913.)—Diagrams are given representing the photographs obtained when X-rays are reflected on rock-salt and quartz. In the case of the latter there are five spots due to the impact of the reflected rays, the central spot and the two outside ones being the more intense. An explanation is given by considering the positions of the molecules, in the quartz, at the corners of hexagons in planes at right angles to the optic axis. The more intense spots are due to reflection by layers of molecules parallel to the three principal directions. The two weaker spots are due to reflection by layers of molecules not so close together as in the former case. In addition to the spots there are, with both rock-salt and quartz, a series of lines which seem to converge towards the points of impact of the reflected rays and are distributed in a way which is very similar to the spectrum obtained with visible light by means of two crossed gratings. This seems to suggest that the directly reflected rays must be regarded as spectra of the order zero. On account of the diffusion of the lines, however, it is not possible at present to deduce from this the wave-length of the X-rays. E. M.

1163. *Pulse Theory of X-Rays, γ-Rays, and Photo-electric Rays.* **W. F. G. Swann.** (Phil. Mag. 25. pp. 534–557, April, 1913.)—It is well known that when a beam of X-rays or ultra-violet rays falls upon a thin sheet of metal, the values for the number and velocity of the β-rays produced are greater for the emergence β-rays than for the incidence ones. In the present paper the author examines the question as to what extent the want of symmetry in the expulsion of these β-rays may be reconciled with the pulse theory. When a beam of electromagnetic rays encounters a free electron the motion which the train produces is generally treated as being wholly transverse to the direction of the beam. The magnetic field of the electromagnetic train acts on the moving electron, however, with a force parallel to the line of motion of the beam, and, in the case of a free electron, this force is such that the total velocity which it has produced since it started to act is always in the direction of the advancing wave, so that the electron will move in the direction of the wave as well as in the transverse direction. Proceeding on this basis, the author calculates the magnitude of the want of symmetry in the expulsion of β-rays. A more powerful theory is, however, deduced by considering the β-rays to arise not from free electrons, but from electrons inside the atoms. A formula is deduced on this basis which corresponds to a case where the electrons are ejected from the atom entirely in the direction in which the waves are travelling. This formula agrees with observations for X-rays, the fact that some β-rays come out against the wave-train being explained as due to scattering. A modified form of this theory is discussed, applicable to photo-electric effects and becoming identical with the theory for X-rays. The paper concludes with some remarks on filamentary pulses and a calculation of a possible relation between the widths of the pulses and the wave-lengths. For the various details, chiefly mathematical, the original paper must be consulted. E. M.

1164. *Production of Fluorescent Röntgen Radiation.* **W. H. Bragg.** (Phil. Mag. 25. pp. 657–659, April, 1913.)—A reply to J. C. Chapman [Abstract No. 997 (1913)], who attacked an hypothesis of the author's [Abstract No. 1496 (1911)], according to which an intermediate kathode ray conveys the energy from the primary X-ray to the homogeneous secondary ray. Chapman's objection is based on an experiment showing that the homogeneous characteristic X-radiation excited in a compound radiator of sheets of gold and paper is independent of the arrangement of the sheets, *i.e.* presumably independent of whether the corpuscles ejected from the gold sheets are absorbed in paper or in other gold sheets. The author objects to Chapman's calculation of the amount of energy of corpuscular radiation which emerges from the gold sheets, as this calculation is based on the absorption of the ejected corpuscles by other gold sheets. It is possible that the excited kathode rays which have special power of exciting homogeneous X-rays in gold are abnormally absorbed, and that very few of them emerge from the foil. The author gives preliminary results of new experiments which are in agreement with his theory. The kathode rays produced by Mo X-rays are shown to be deficient in both penetration and ionising power in ethyl bromide. This would follow from the theory, since Mo is of slightly higher atomic weight than Br, and Mo-rays can therefore excite the characteristic homogeneous X-rays in Br and thus lose energy in this special way.

E. M.

1165. *Excitation of γ-Rays by the α-Rays of Ionium and Radio-thorium.* **J. Chadwick** and **A. S. Russell.** (Roy. Soc., Proc. Ser. A. 88. pp. 217–229, March 31, 1913.)—It has been shown by Chadwick [Abstract No. 431 (1913)] that when the α-particles of RaC impinge on matter, a small amount of γ-radiation is excited. In the present experiments this result has been extended to the α-rays of ionium, and owing to the absence of primary β- or γ-radiation, it has been possible to study the excited γ-rays in much more detail. The preparation of ionium used consisted of 1·2 gm. of a mixture of the oxides of ionium and thorium emitting about 10^8 α-particles per sec., *i.e.* the mixture contained a quantity of ionium equivalent to the amount of radio-active equilibrium with 3 mgm. of Ra. All radio-active impurities emitting considerable amounts of β- or γ-rays were first separated by chemical means. The resulting substance had a β and γ activity of 13·3 divs./min. under the experimental conditions, of which 12·0 divs./min. was due to γ-rays. Observations were made of the absorption of the γ-rays by Al, the small amount of β-rays being prevented from entering the electroscope by means of a strong magnetic field. The radiation was found to consist of three distinct types whose values of μ/D were I. 400 ; II. 8·35 ; III. 0·15 ; μ being the absorption coefficient in Al of density D. It is shown that most of the energy of the whole radiation is confined to the softest type, *i.e.* Type II. appears to have the penetrating power corresponding to Barkla's characteristic excited X-radiation of series L in either ionium or thorium, and presumably I. and III. are types of characteristic radiation corresponding to other series not yet fully known. The results are thus in agreement with Rutherford's idea [Abstract No. 433 (1913)] that the γ-rays of radio-active bodies are the characteristic X-radiations of these bodies. Further experiments with Radio-Th showed that this product also emits a small quantity of soft γ-radiation.

E. M.

HEAT.

1166. *Measurement of Specific Heats of Metals at High Temperatures.* **O. M. Corbino.** (Accad. Lincei, Atti, 22. pp. 430–437, April 6, 1913.)—For the determination of the specific heats at high temperatures, of Pt and other metals, the author has slightly modified the method previously described [Abstract No. 1068 (1912)]. The metal filament, which still forms one of the arms of a Wheatstone bridge, is suspended in a vessel capable of being evacuated by means of a Gaede pump to 0·0001 mm. By suddenly reducing the resistance in the principal circuit the current in the filament, and consequently its temperature, is increased, and from this the ratio *c*/*a* is deduced. W. H. Sl.

1167. *Adiabatic Expansion in Liquids.* **L. Gay.** (Comptes Rendus, 156. pp. 1070–1072, April 7, 1913.)—The author has devised an apparatus for measuring the dilatation produced in liquids by adiabatic expansion from a pressure of 2 atmos. to 1 atmo. From the results obtained with mercury, water, and benzene, the values of the coefficient of isothermal compressibility, β, are calculated from the expression $\beta = \gamma + T\alpha^2/41{\cdot}8cD$, where γ is the coefficient of adiabatic compressibility (which is obtained experimentally), α the coefficient of thermal expansion, c the specific heat at constant pressure, and D the density. The values obtained correspond moderately well with those found by Amagat [see Abstract No. 1258 (1909)]. T. H. P.

1168. *Experiments on Heat Insulation.* **F. A. J. FitzGerald.** (Amer. Electrochem. Soc., Trans. 21. pp. 535–541; Discussion, pp. 541–544, 1912.)—Some experiments with furnaces built up of various kinds of fire-bricks enclosing a cylindrical resistor of alundum wound with nichrome wire. The *discussion* by **M. M. Kohn** and **L. H. Duschak** concerned chiefly the influence of cellular spacing. H. B.

1169. *Hydrogen- and Resistance-thermometer between* 0° *and* −193° *C.* **F. Henning.** (Ann. d. Physik, 40. 4. pp. 665–667, April 15, 1913. Communication from the Physikal.-Techn. Reichsanstalt.)—Platinum and lead thermometers are compared with the hydrogen thermometer between 0° and −193° C. The accuracy of the gas thermometer at constant volume is discussed and a simple formula deduced for the calculation of the gas thermometer temperature. The measurements were made in liquid air, liquid oxygen, and, beyond −150°, in a specially constructed thermostat, whose temperature could be kept constant to within 0·02 to 0·03°. The Callendar formula for the Pt-thermometer holds till −40°. At −193° the difference is over 2°. Elaborate tables are given with the constants relating to the gas- and Pt-thermometers. J. J. S.

1170. *On the Rectilinear Diameter for Argon.* **E. Mathias, H. Kamerlingh Onnes,** and **C. A. Crommelin.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 667–673, Nov. 28, 1912, and pp. 960–965, April 24, 1913. Communication No. 131a from the Phys. Lab., Leiden. Comptes Rendus, 156. pp. 129–132, Jan. 13, 1913.)—The authors have determined the following values for the densities of liquid and vaporous argon, and the ordinates of the diameter :—

Bath.	$t_K = T - T_{0°C}$ Kelvin degrees.	$\rho_{liq.r}$	$\rho_{vap.r}$	$D_{\rho r}$(Obs.).	$D_{\rho r}$(Calc.).	O – C.
O_2......	– 183·15	1·37396	0·00801	0·69099	0·69006	+ 0·00093
CH_4 ...	– 175·39	1·32482	0·01457	0·66970	0·66970	—
CH_4 ...	– 161·23	1·22414	0·03723	0·63069	0·63255	– 0·00186
C_2H_4...	– 150·76	1·13851	0·06785	0·60318	0·60508	– 0·00190
C_2H_4...	– 140·20	1·03456	0·12552	0·58004	0·57738	+ 0·00266
C_2H_4...	– 135·51	0·97385	0·15994	0·56690	0·56507	+ 0·00183
C_2H_4...	– 131·54	0·91499	0·19432	0·55466	0·55466	—
C_2H_4...	– 125·17	0·77289	0·29534	0·53412	0·53794	– 0·00382

The slope of the diameter is given by $b_d r = - 0·0026235$, which is a larger coefficient than is found for any other substance except xenon. The deviations of the diameter from rectilinearity are sufficiently small to enable us to say that argon obeys the law of the diameter, but they are too large and too systematic to be due to experimental errors.

The authors also discuss the deviations of equations of state for different substances from one another. [See also Abstract No. 1851 (1912).] A. F.

1171. *Isotherms of Monatomic Substances and of their Binary Mixtures.* XIV. *Calculation of Thermal Quantities for Argon.* **H. Kamerlingh Onnes** and **C. A. Crommelin.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 952–960, April 24, 1913. Communication No. 133*c* from the Phys. Lab., Leiden.)—The empirical reduced equation of state for argon [see Abstract No. 1851 (1912)] allows of the calculation of a number of thermal quantities which are essential to a knowledge of monatomic substances in general and of argon in particular. These quantities may also be obtained graphically, but calculation by means of an equation which fits the experimental results over the whole region of observation admits of greatly increased accuracy. The present paper contains values of $(\partial p/\partial T)_v$, $(\partial^2 p/\partial T^2)_v$, $(\partial \gamma_v/\partial v) = T(\partial^2 p/\partial T^2)_v$, $(\partial u/\partial v) = T(\partial p/\partial T)_v - p$, and of Reinganum's a and $a_R = [T(\partial p/\partial T)_v - p]v^2$, calculated as functions of the temperature and of the density from the equation referred to above; the temperature is expressed in Kelvin degrees, and is calculated from 0° C., while the pressure is expressed in international atmospheres. The importance of a knowledge of these quantities, especially as functions of the temperature, has been repeatedly emphasised [see Reinganum, Abstract No. 329 (1906)], but it may be pointed out that, according to the main van der Waals' equation with constant a_w, b_w, and R_w, $(\partial p/\partial T)_v$, the values of $(\partial u/\partial v)_T$ and a_R should be independent of the temperature, and consequently $(\partial^2 p/\partial T^2)$ should vanish, so that the deviations which they all show may be taken as a measure of the degree to which argon diverges from the simple assumptions regarding molecules accepted by van der Waals in developing his principal equation. At least approximate agreement with the van der Waals' equation would first be expected with monatomic substances, and comparison of the results obtained for argon with those for substances of more complex molecular structure should lead to conclusions of the greatest importance. As regards $(\partial p/\partial T)_v$, the behaviour of argon corresponds in many respects with that of isopentane. For this hydrocarbon Young (Phys. Soc., Proc. 13. p. 602, 1895) found that

$(\partial p/\partial T)_v$ decreases as the temperature falls when v_T is less than 4·6 c.cm.; for greater volumes up to 400 c.cm. it increases as the temperature falls, while it remains practically constant at still greater volumes. In the case of argon, for which the volumes are expressed in terms of the normal volume as unit, if the law of corresponding states were accurately obeyed these volumes would correspond with $v_N = 0{\cdot}00877$ and 0·828 or $\rho_N = 265$ and 8·05. The observations made on argon lie entirely within these limits, and argon agrees with isopentane over the whole region. The value of $(\partial p/\partial T)_v$ always falls with rise of temperature, but at the lowest density the diminution becomes extremely small, pointing to constancy at still lower densities. As with isopentane, so also with argon, the value of $(\partial^2 p/\partial T^2)_v$ is less than zero when v is greater than $\pm v_k$. T. H. P.

1172. *Propagation of Explosions in Mixed Gases, and on the Limits of Inflammability.* **E. Jouguet.** (Comptes Rendus, 156. pp. 872–875, March 17, and pp. 1058–1061, April 7, 1913.)—A theoretical treatment.

1173. *Present Status of the Temperature Scale.* **G. K. Burgess.** (Chem. News, 107. pp. 169–171, April 11, and pp. 182–184, April 18, 1913. Paper read before the Internat. Congress of Applied Chemistry, New York, 1912.)

1174. *A New Entropy Analogue.* **V. Karapetoff.** (Gen. Elect. Rev. 16. pp. 7–15, Jan., 1913. Eng. News, 69. pp. 406–409, Feb. 27, 1913.)

1175. *On Two Fundamental Inequalities in Thermodynamics.* **P. Duhem.** (Comptes Rendus, 156. pp. 421–424, Feb. 10, 1913.)

1176. *Radiation Determinations.* **W. Gerlach.** (Ann. d. Physik, 40. 4. pp. 701–710, April 15, 1913.)—Defends the author's position against criticisms that have been advanced. [See Abstracts Nos. 1229 (1912) and 99 (1913).] E. H. B.

SOUND.

1177. *Pianoforte Touch.* **G. H. Bryan.** (Phys. Soc., Proc. 25. pp. 147–156; Discussion, pp. 156–159, April, 1913.)—The author discusses Helmholtz's and Kaufmann's theories of the vibrations of a pianoforte wire excited by impact, with special reference to the effects obtainable with the modern pneumatical piano-players and player-pianos, and the common widespread belief that these can never reproduce the touch of the human fingers. While the rendering of many commercial piano-players in the hands of an average performer bears little resemblance to the performance of a professional pianist, the author finds that there is generally believed to be a certain element missing even in music played by a skilled performer on a first-class modern piano-player, this missing element being commonly associated with what is described as "touch."

The question turns very largely on the extent, if any, to which the *quality* of individual notes can be varied by striking the notes in different ways, namely, so as to cause different time variations of pressure on the keys while they are being depressed. The author then describes a device to control the touch to some extent. In the *discussion*, **G. H. Berry** said that with regard to the question of varying the time of contact of hammer with string by variations in the touch, in his opinion it was impossible to do this. When the hammer was in contact with the string the key was entirely disconnected from it, and also the *check* was merely a repetition device, and did not come into action until the hammer had left the string. The only thing that could be varied (neglecting the loud and soft pedals) was the velocity with which the hammer struck. It seemed to him that Bryan's device gave a greater control over this velocity. **T. H. Churton** said an examination of the mechanism of a piano made it evident that, no matter how a key was depressed, the result depended entirely upon the velocity imparted to the hammer that struck the wire or wires, and that the only further effect of holding the key down was to hold the damper off the wires. It was therefore evident that no variety of tone could be produced in a piano that depended upon the striking of the key which could not be produced by suitable mechanical means for striking the key with the required force. But what was ordinarily conveyed by *touch* was not tone production, nor degree of force used, but the effect produced by (1) the relative loudness of the notes played whether struck simultaneously or in sequence; (2) the relative duration of the notes and rests (*staccato* or *legato*); and (3) the slight variations from the strict time of playing individual notes or groups of notes. The author quoted some experiments to show that the quality of tone was affected by the time of contact of hammer and wire. E. H. B.

1178. *Transverse Vibrations of Strings.* **G. Sizes.** (Comptes Rendus, 156. pp. 1234–1236, April 21, 1913.)—Describes observations on the vibrations of a piano string (la_{-1}) of 27 per sec., and showing *undertones* as well as the usual overtones. The relations of the frequencies of the tones observed are as follows:—

Undertones ...	1, 4, 5, 6, 7, 8, 10, 12, 14, 16, 18, 20, 30, 32, 40, 48, 60.
Prime tone ...	64 (really 27 per sec.).
Overtones ...	96, 128, 160, 192, 256, 512, 576.

E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1179. *Unipolar Induction.* **E. H. Kennard.** (Phys. Zeitschr. 14. pp. 250–251, March 15, 1913.)—A further reply to S. J. Barnett [see Abstract No. 1859 (1912) and 209 (1913)]. The fact that the charge on a cylindrical condenser revolving in a magnetic field is independent of the dielectric constant may be amplified as follows :—When a rigid system consisting of conductors and an homogeneous dielectric surrounded by a conducting surface revolves about a magnetic axis of symmetry (or "is cut by moving lines of force"), any distribution of electrification which may take place is independent of the dielectric constant. E. E. F.

1180. *Electric Conduction by Free Electrons and Carriers.* **P. Lenard.** (Ann. d. Physik, 40. 3. pp. 393–487, March 20, 1913.)—The first part of a theoretical treatise in which it is endeavoured to collate and systematise existing experimental knowledge on these subjects and present an embracing theory of the phenomena. [See Abstract No. 1479 (1910).] E. H. B.

1181. *Law of Induction and Electron Theory.* **K. Pichelmayer.** (Elektrotechnik u. Maschinenbau, 31. pp. 462–466, June 1, 1913.)—A theoretical discussion of the phenomenon of current induction in the light of the electron theory. G. E. A.

1182. *On the Electrification associated with Dust-clouds.* **W. A. D. Rudge.** (Phil. Mag. 25. pp. 481–494, April, 1913.)—The paper describes some laboratory experiments made on the electrification of dust particles raised into a cloud by the passage of a current of air. It is found that the sign of the charge depends on the nature of the material of which the dust is composed ; non-metallic elements give positively-charged clouds, metallic elements negatively-charged ones. Further experiments showed that the air containing the dust-cloud was oppositely charged to the dust particles. Illustrations are given of "Lichtenberg" figures formed by allowing the charged dust particles to settle upon an ebonite plate which has been touched for an instant with the knob of a charged Leyden jar. J. S. Di.

DISCHARGE AND OSCILLATIONS.

1183. *Generation of Light by Canal Rays.* **L. Vegard.** (Ann. d. Physik, 40. 4. pp. 711–734, April 15, 1913.)—The author has previously made a number of observations and measurements with the object of ascertaining the law governing the generation of light in gases at low pressures, and especially studied the light-emission by canal rays [see Abstract No. 118 (1913)]. That research, which dealt chiefly with the emission of the hydrogen series spectrum, led to a result which stands in express contradiction to the explanation offered by Stark of the connection between light-emission and the kinetic energy of the rays. Stark has offered further explanations tending to make the results obtained accord with his original hypothesis [see Abstract No. 601 (1913)]. As a result of the present investigation the following are among the conclusions arrived at :—The displacement of the ratio H_α/H_β observed by Stark and Steubing is still unexplained. Only a small fraction of the effect can be explained by the effect and relationships observed by the author. The pressure effect with the intensity distribution of the series spectrum is purely a pressure effect. The moving intensity shows no established alteration of the intensity distribution with the potential. Stark's explanations are still further criticised. A. E. G.

1184. *Primary Velocity of Canal Rays under Different Conditions.* **K. Glimme** and **J. Koenigsberger.** (Deutsch. Phys. Gesell., Verh. 15. 7. pp. 267–270, April 15. 1913.)—It has not yet been definitely proved whether the primary velocity of the canal rays depends solely upon the p.d. in the discharge tube. In the present experiments the max. velocity of hydrogen atoms is compared with the discharge potential of an electric machine giving about 2×10^{-4} amp. current, by means of the electrostatic deflection of the positive hydrogen canal rays in a high vacuum. It is found that the form of the discharge tube has no effect. The max. velocity of these canal rays, under the conditions investigated, is independent of the causes which determine a certain discharge potential ; it always corresponds to the latter, and stands in constant relationship to the kathode-ray velocity. A. E. G.

1185. *Various Photoelectric Phenomena of Anthracene and their Relations to Fluorescence and Formation of Dianthracene.* **M. Volmer.** (Ann. d. Physik, 40. 4. pp. 775–796, April 15, 1913. Extract of Habilitationsschrift, Leipzig.)—Photoelectric sensitiveness of dissolved substances, which is rendered evident in increased conductivity of the solutions, may be due either to direct ionisation similar to that of a gas by ultra-violet light or to photochemical formation of a new substance which undergoes strong electrolytic dissociation. The first of these effects has not yet been observed. According to Byk and Borck [see Abstract No. 1478 (1910)], the increase produced in the conductivity of anthracene solutions under the influence of light is due to the formation on the electrodes of a solid layer, which exhibits the Hallwachs-effect. The author finds that in the region of the spectrum which causes fluorescence and effects polymerisation of anthracene, namely about 400–225 $\mu\mu$, no Hallwachs-effect appears, whereas increased conductivity of solid anthracene is observed in this region. In this light a new photoelectric phenomenon has been discovered with anthracene and with sulphur, consisting in the emission of positive or negative ions of the solid body into the solvent under the influence of an electric field. In the same region of the spectrum solutions of anthracene in pure hexane exhibit marked increase in conductivity. Solid anthracene shows the Hallwachs-effect only with wave-lengths of less than 225 $\mu\mu$. The experimental results indicate that Byk's theory of the formation of dianthracene is inadmissible in so far as it assumes separation of electrons as the primary action. From that part of Stark's theory of fluorescence which supposes total separation of the electrons, the author's results in various instances remove experimental support. The view is advanced that photochemical processes, especially the formation of anthracene, may be regarded as a consequence of alteration in the state of vibration of the valency electrons. This view is illustrated with the help of Thiele's formula for the anthracene molecule. T. H. P.

1186. *Absorption of Heat produced by Emission of Ions from Hot Bodies.* **H. L. Cooke** and **O. W. Richardson.** (Phil. Mag. 25. pp. 624–648, April, 1913.)—Richardson has previously pointed out [see Abstract No. 1489 (1904)] that there should be a considerable stream of energy away from the surface of a hot body which is emitting electrons or ions. When the total thermionic current is i, the rate of loss of energy is $i(\Phi + 2R\theta/e)$, where Φ is the drop of potential through which an ion would have to fall in order to acquire the energy which is equal to the heat rendered latent when the ion is emitted by the substance, R is the gas constant for a single molecule, e the charge on an ion, and θ is the temperature of the substance. Attempts to detect this loss of energy have been made by Wehnelt and Jentzsch and by Schneider [see Abstracts Nos. 1079 (1909), 1418 (1912)]. These investigators all used a lime-coated Pt-wire as source of electrons. They agree in observing a cooling effect which is generally larger than that given by the above theory. They did not, however, take the precaution to eliminate or allow for the direct disturbing action of the thermionic current on the galvanometer of the Wheatstone bridge system. There is also possibly something about the emission from lime that makes its behaviour exceptional. The experiments made by the authors were carried out with filaments of osmium as the source of emission. A diagrammatic representation of the experimental arrangement and a detailed theory of the measurement are given. The experiments afford a strong confirmation of the views about the nature of the emission of electrons from hot bodies which have been put forward by Richardson. In particular, since osmium is closely related to Pt both chemically and physically, we should expect it to have a very similar value of ϕ. The value obtained is very close to the value of the corresponding quantity which has been obtained from the converse heating effect when electrons were absorbed by Pt, and is not very different from the values of the latent heat, expressed in equivalent volts, which have been deduced from the temperature variation of the emission of electrons by Pt. A. E. G.

1187. *Temperature of Kathode and Anode in a Geissler Tube.* **B. Hodgson.** (Phil. Mag. 25. pp. 453–461, April, 1913.)—A special form of discharge tube is described in which one of the electrodes has a cavity drilled so as to admit the bulb of a thermometer. Curves and tables are given showing the results obtained in air, oxygen, and CO_2; there is also a detailed theoretical consideration of the observed phenomena. The general results are as follows:—A linear relationship exists between the current through a vacuum tube and the heat-energy communicated to the kathode both for normal and abnormal kathode-glow, this effect being a minimum at a certain pressure for a constant current. It is possible that this minimum coincides with that found by Ebert, at which a discontinuity occurs in the relationship between pressure and width of the dark space; further experiments on this point are in progress. The ratio between the positive and negative carriers at the kathode is approximately 10 : 1. A linear relationship also exists between current and heat energy at the anode, though for the same pressure and current the heat communicated is much less than in the case of the kathode. The change in pressure produces much greater changes in temperature than in the kathode. The kathode-fall is able to account for the heat energy given to the kathode, but the anode-fall alone cannot do so for the anode. A. E. G.

1188. *Stratified Vacuum Discharges.* **E. Riecke.** (Phys. Zeitschr. 14. p. 230, March 15, 1913.)—The stratification of the positive column in some cases, and the want of stratification in others, may be explained by the difference between the ionising potentials of the positive and negative ions. If these have a common factor, ionisation by collision will occur in definite planes. If not, it will occur in all sections of the positive column equally, and no stratification will occur. The simplest case is when the ionisation potentials for + and — ions are the same. To complete the theory, it will be necessary to determine the relation between ionisation potentials for + and — ions in the same tube. E. E. F.

1189. *Instantaneous Braun-tube Photographs.* **J. Zenneck.** (Phys. Zeitschr. 14. pp. 226–229, March 15, 1913. Rev. Électrique, 19. pp. 566–568, June 20, 1913.)—It has lately become possible to take instantaneous photographs of oscillographic curves by means of Braun's kathode-ray tube, owing to the increased luminosity available. The author describes an attachment to an ordinary camera suitable for taking such photographs, and reproduces some fine specimens of results, including that obtained with a damped condenser circuit of frequency 250 per sec. The fluorescent substance used was Giesel's zinc sulphide. E. E. F.

1190. *Kathodic Sputtering.* **G. W. C. Kaye.** (Phys. Soc., Proc. 25. pp. 198–201; Discussion, pp. 201–202, April, 1913.)—Gives an account of the volatilisation of an Al kathode in a discharge tube containing helium. The sputtered deposit on the glass indicates that, under the conditions which prevailed, the disintegration was restricted to the edges of the kathode and did not occur elsewhere. Accordingly the complete outline of the kathode (made by rolling a sheet of Al into a nearly complete cylinder) was traced out by the deposit on the walls of the tube. L. H. W.

1191. *Anode Phenomena in Vacuum Discharges.* **W. G. Cady.** (Phys. Zeitschr. 14. pp. 296–302, April 1, 1913.)—When small particles of oxide occur on the anode during a glow discharge, the positive column tends to concentrate upon them. With a sufficiently strong current an arc forms on the oxidised patches. Experiments were made with Cu, Hg, Fe, and Ag electrodes in nitrogen containing traces of oxygen. The nomenclature of the various stages is discussed in connection with the observations of Buisson and Fabry, Hagenbach and Veillon, and Occhialini. E. E. F.

1192. *Reflection of Electric Waves by Ionised Gases.* **J. Salpeter.** (Phys. Zeitschr. 14. pp. 201–208, March 1, 1913.)—Gives expressions for the dielectric constant, the conductivity, the refracting, reflecting, and absorbing powers of a gas in terms of its pressure and degree of ionisation. Shows that the conductivity of a gas for high-frequency oscillations is only a small fraction of its d.c. conductivity. The results are substantially the same as those obtained by W. H. Eccles [Abstract No. 1254B (1912)]. E. E. F.

1193. *Oscillations of the Poulsen Arc.* **H. Fassbender** and **E. Hupka.** (Phys. Zeitschr. 14. pp. 222–226, March 15, 1913. Communication from the Physikal.-Techn. Reichsanstalt.)—According to Blondel and Simon [Abstracts Nos. 1918 (1905), 1423 (1906)] the singing arc shows three varieties of oscillation. In the first there is no interruption and the current curve is very nearly a sine curve. In the second there is an extinction in the course of each period, and the p.d. rises after each extinction until the arc lights up. In the third variety the lighting-up after each extinction occurs in the opposite direction. These varieties have been demonstrated with the Blondel oscillograph for frequencies up to 10,000 ∿ per sec. The authors tested the Poulsen arc up to 100,000 ∿ per sec. for the same varieties of oscillation, a Braun tube serving as oscillograph. They found oscillations of the first and second types. E. E. F.

1194. *Exact Mechanical Analogy to Coupled Circuits used in Wireless Telegraphy, and a Geometrical Method of Interpreting the Equations of such Circuits.* **T. R. Lyle.** (Phil. Mag. 25. pp. 567–592, April, 1918.)—If a horizontal beam of mass M is so supported that it can move freely in the direction of its length and from it two simple pendulums of lengths l_1 and l_2 with bobs of masses m_1 and m_2 are suspended from the beam by V suspensions so arranged that the bobs are constrained to move in the vertical plane through the axis of the beam, the system when making small oscillations is identical with a pair of coupled circuits. Taking the coupling for a pair of circuits as $\mathrm{M}/\sqrt{(\mathrm{L}_1\mathrm{L}_2)}$, where M is the mutual induction and L_1, L_2, are the self-inductions, the coupling for the mechanical system is—

$$\sqrt{[m_1 m_2/(\mathrm{M}+m_1)(\mathrm{M}+m_2)]}.$$

Both mechanical and electrical systems satisfy the equation—

$$[\cos^2\psi\,\mathrm{D}^4+(\mu_1^2+\mu_2^2)\,\mathrm{D}^2+\mu_1^2\mu_2^2]\,\phi=0\ldots\ldots\ldots\ldots(1),$$

where $\sin\psi=$ coupling, μ_1 and μ_2 represent the natural periods of the circuits or simple pendulums, and D is the operator d/dt. In the mechanical system the angular displacements of the pendulums correspond to the p.d.'s across the condensers of the coupled circuits and their angular velocities represent the currents in the circuits. The coupling of the mechanical system can be altered by loading the beam. If a is written for μ_1^2 and b for μ_2^2 and a and b are drawn as sides of a triangle including an angle 2ψ, and if the equation (1) is solved in the usual way by obtaining the factors of the operator considered as a simple quadratic function, the roots of the quadratic are: $-ab/s$ and $=-ab/s-c$, where c is the closing side of the above triangle and $2s=a+b+c$, and the equation (1) reduces to $(\mathrm{D}^2+\omega_1^2)(\mathrm{D}^2+\omega_2^2)\,\phi=0$, where $\omega_1^2=ab/s$ and $\omega_2^2=ab/s-c$. This geometrical method of presenting the solution for the resultant frequencies simplifies many of the considerations relating to coupled circuits. The method is applied to several cases, and the analogy between the mechanical and electrical systems fully worked out. The apparatus is fully described. T. P. B.

1195. *Resistance of Flat Spirals and Short Cylindrical Coils for High-frequency Oscillations.* **R. Lindemann** and **W. Hüter.** (Deutsch. Phys. Gesell., Verh. 15. 7. pp. 219–236, April 15, 1918. Communication from the Physikal.-Techn. Reichsanstalt.)—The paper is an extension of one already abstracted on the resistance of stranded cables [see Abstracts Nos. 1187 (1910) and 1187B (1911)]. The experiments are here extended to coils of copper strip. It is found that the strip shows a smaller "skin-effect" than round wire of the same cross-section. The resistance of flat spirals is also investigated, and the results show that these coils have a higher resistance than cylindrical coils, all else being equal. Coils of similar characteristics made of solid wire, strip, and stranded wire are compared. For short cylindrical coils and for spirals the resistance rises proportionally to $1/\sqrt{\lambda}$ for long wave-length (λ), and to $1/\lambda^2$ for short wave-length. The resistance r of short cylindrical coils of solid wire is given by a formula of the form $r=\mathrm{A}/\sqrt{\lambda}+\mathrm{B}/\lambda^2$. This holds down to a wave-length of 200 m. T. P. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1196. *Electrical Conductivity of Tellurium.* **Mlle. P. Collet.** (Comptes Rendus, 156. pp. 943–945, March 25, 1913.)—Three masses of polished tellurium were examined with faces of 0·5 to 2·0 mm. thickness. The crystalline orientation had no influence on the results. (1) Whilst the pressure is lower than a value P_1 (30 to 40 gm. per sq. mm.) the resistance varies irregularly owing to bad contacts. From P_1 to a pressure P_2 the resistance remains constant. Above P_2, the potential remaining constant, increase of pressure produces a diminution of resistance. (2) During about a minute after the passage of a current the Te is the seat of a residual e.m.f. of which the magnitude and direction depend on the nature of the contacts. (3) For periods of time exceeding some seconds the resistance is a function of the time during which the current passes. For periods of a fraction of a second the resistance has for each intensity a single definite value independent of the time during which the current flows. (4) If e is the e.m.f., i the intensity of current, the curve showing the relations of e and i starts from the origin with a somewhat high inclination. Sometimes at first it is rectilinear, then a sharp bend leads to a parabolic branch with large curvature ($i = ae^2 + be + c$). This occurs with contacts a little unstable, with electrodes not quite closely joined and made up of points. Sometimes, on the contrary, the curve has a parabolic form from the origin ($i = ae^2 + be$); the bend disappears, and for currents of about 1 amp. the two sorts of curve become parallel. J. J. S.

1197. *Variation of Resistance of Selenium due to X- and Radium-rays.* **H. Guilleminot.** (Comptes Rendus, 156. pp. 1155–1157, April 14, 1913.)—The author shows that, under X- and γ-rays, the resistance of selenium falls by nearly 25 % in some cases, the resistance taking several minutes to come to its final value. A table of quantitative results is given. E. M.

1198. *Light-radiation and the Telephone.* **O. Grotrian.** (Ann. de Physik, 40. 4. pp. 812–814, April 15, 1913.)—The paper continues the work of one previously abstracted [see Abstract No. 676 (1913)]. It is here shown that the effect there referred to is due to a change in the permeability of the iron of the membrane. Experiments are described showing that the effect is not due to the bending of the membrane by heat. The direction of the induced current is not always the same. This is due to the different magnetic state of the membrane at the outset. The question whether ultra-violet radiation causes any effect is not yet settled. T. P. B.

1199. *Measurements of Inductance.* **A. O. Allen.** (Phil. Mag. 25. pp. 520–534, April, 1913.)—In null methods of inductance measurement there is a marked difference in the behaviour of the galvanometer, according to whether the balance is continuous or merely aggregate. This was pointed out in 1883 by Rayleigh (B. A. Report), who also showed that two conditions must be fulfilled if the balance is to be continuous. In the present paper it is further shown that these two conditions are sufficient in all cases. When the balance is not a continuous one the duration of the flow through the galvanometer in the two directions is calculated. Most of the methods for measuring inductances are considered, and the conclusion seems to be that far too much has been made of the importance of a continuous balance, and that unsteadiness of the needle is in many cases attributable to the residual charge of any condenser in use, or similar capacity effect. F. E. S.

1200. *The Silver Voltameter.* **G. D. Buckner** and **G. A. Hulett.** (Amer. Electrochem. Soc., Trans. 22. pp. 367–383, 1912.)—It was found that the slightest traces of impurities, such as dust and organic matter, so affected a silver nitrate solution that it gave abnormally heavy deposits. Particular attention was therefore paid to preparing a reproducible electrolyte. It was necessary to take unusual precautions in preparing all materials, and the vessels used were of quartz, gold, and platinum. Silver nitrate was obtained from "atomic-weight" silver and pure nitric acid; with this a solution was prepared which contained exact equivalents of Ag and NO_3. Kahlbaum's commercially pure $AgNO_3$, recrystallised and fused, gave a deposit 0·009 per cent. heavier than that obtained with this normal electrolyte, and other solutions yielded distinctly heavier deposits. Deposits on gold and on platinum were made, the deposits on gold being always the heavier; the average excess being 12 parts in 100,000. With commercially pure $AgNO_3$ solution the Rayleigh form gave a deposit 0·036 per cent. heavier than normal. Experiments with porous-cup voltameters showed that if the anode liquid comes into contact with the kathode a deposit heavier by 0·019 per cent. is obtained. F. E. S.

1201. *Sensitive Electrometer.* **C. Mülly.** (Phys. Zeitschr. 14. pp. 237–240, March 15, 1913.)—In order to utilise the very feeble directive force of Wollaston fibres of diam. 3 to 7 μ it is essential that the period and damping should not be great. To reduce the moment of inertia the vanes of the electrometer needle are bent down, and fit in between vertical cylindrical quadrants which take the place of the horizontal quadrants. The dimensions selected are: Height of quadrants, 12 mm.; external diam. of inner quadrants, 8 mm.; internal diam. of outer quadrants, 16 mm.; diam. of needle, 12 mm.; play of needle, 4 mm. The sensitiveness may be varied slightly by raising or lowering the needle. With a Wollaston fibre 5 μ in diam. and the needle at 105 volts, the instrument gives 45,000 scale divisions per volt on a scale at 3 m. The period is 10 to 17 secs., and the needle reaches its final position after about 3 oscillations. E. E. F.

1202. *Vibration Galvanometers with Unifilar Torsional Control.* **A. Campbell.** (Phys. Soc. Proc. 25. pp. 203–204; Discussion, pp. 204–205, April, 1913.)—In the Campbell vibration galvanometer, the control being elastic (bifilar), the final tuning is brought about by altering the tension of the wire. The author finds that the torsional rigidity of a phosphor-bronze strip, when under tension, is considerably increased as the tension is raised [see also Abstract No. 605 (1913)]. He has used this new system of unifilar tuning both in the moving-coil and moving-iron vibration galvanometers, and finds it very convenient; in the moving-coil instrument minute hooks on the ends of the strips engage in contact-hooks at the top and bottom of the coil, which is easily detachable. With a mirror of 15 sq. mm. area, at 100 ∿ per sec., a sensitivity of 50 mm. at 1 m. per microamp. can be obtained, the effective resistance being about 700 ohms. The anomalous behaviour of the phosphor-bronze strip is attributed by Pealing to overstrain during the process of manufacture. In the *discussion,* **C. H. Lees** remarked that it seemed natural for a strip to behave like a bifilar. The **Author,** in reply, attributed the behaviour of the strip to bifilar action in the case of short strips, but did not consider this the whole explanation in the case of long strips. W. C. S. P.

ALTERNATING CURRENTS AND MAGNETISM.

1203. *The Hysteresis Loop and Index.* **W. M. Thornton.** (Electrician, 71. pp. 214–217, May 16, 1913.)—The paper is a brief analysis of the forms of electric and magnetic hysteresis loops. It is found that a magnetic loop formed of curves, taken to be the same on both the rising and falling sides, agrees as closely with experimental results in alternating fields as the loops obtained by the point-to-point method, and that the mean of the indices corresponding to these agrees with the Steinmetz coefficient 1·6, defined by $W = \eta B^{1.6}$, very closely, W being the energy dissipated per cycle and B the max. flux-density. The physical meaning of an index 1·5 is shown to be that the residual flux is proportional to the max. number of molecular magnets per cm. length ranged in line with the field per cycle, and the slightly higher index observed is explained by a linear polarisation in weak fields, giving rise to a coercive force proportional to the max. flux-density—that is, to the closeness of packing of molecules which are ranged into line with the field in a plane at right angles to it. **L. W. Wild, W. M. Thornton.** (Ibid. 71. p. 269, May 23 ; 324, May 30, and pp. 362–364, June 6, 1913.)—In correspondence following the appearance of Thornton's paper, it is stated by Wild that the hysteretic index may reach values much higher than 2·5 ; but this is contradicted by Thornton. G. E. A.

1204. *Hall-effect.* **J. Koenigsberger** and **G. Gottstein.** (Phys. Zeitschr. 14. pp. 232–237, March 15, 1913.)—The Hall-effect fits into the electron theory of metals satisfactorily on the whole, although special assumptions have occasionally to be made. These are, however, not more unreasonable than those which have to be made in the kinetic theory of gases. Beattie's rule that the Hall-effect and the thermoelectric force vary correspondingly points to a connection between magnetic properties, thermoelectricity, and electronic pressure. If we explain the occasionally reversed Hall-effect by assuming an internal field opposed to the magnetising field, we may picture electrons entering the atomic fields and having their motion reversed by semicircular swings. This would also imply a difference of sign in the thermoelectric force with respect to the normal metal, since the electronic pressure would be practically negative. This disposes of one of the difficulties of the electron theory. [See Abstract No. 840 (1901).]
E. E. F.

1205. *Magnetic Properties of Certain Solid Hydrates of Copper and Chromium.* **Mlle. E. Feytis.** (Comptes Rendus, 156. pp. 886–889, March 17, 1913.)—The various molecules of water present in the hydrates of copper sulphate are not similar as regards their magnetic relations [see Abstract No. 1729 (1911)]. The same is now found to be the case with the hydrates of cupric chloride. The magnetic susceptibility of the anhydrous chloride is markedly lower than that calculated from the value for $CuCl_2, 2H_2O$, and very nearly equal to that calculated for $CuCl_2, H_2O$. The structures of the two salts, $CuSO_4 . 5H_2O$ and $CuCl_2 . 2H_2O$ may hence be expressed thus: $(CuSO_4, H_2O) + 4H_2O$ and $(CuCl_2, H_2O) + H_2O$. Measurement of the specific and molecular susceptibilities of a number of anhydrous and hydrated double salts of cupric and other chlorides shows that here too the property is additive in no single case. Further, the molecular susceptibilities of the anhydrous double salts, which, like cupric chloride, are brown, vary little from a mean value of 1230×10^{-6}, whilst those of the green or blue hydrated salts have values of about 1400×10^{-6}; these results tend to confirm Wiedemann's observation that compounds of the same type have the same molecular susceptibility. The lowering of the value by loss of water is probably connected with modifications in the constitution of the salts. The attribution of different rôles to the various molecules of water in the green and violet hydrates of chromic salts is not justified by their magnetic susceptibilities. Thus, the isomeric green chloride $[CrCl_2(H_2O)_4]\,Cl + 2H_2O$, and the violet one $[Cr(H_2O)_6]Cl_3$, have the same susceptibility. Also, with the different violet and green hydrates of chromic sulphate, the susceptibility is an additive property in all cases; additivity is also observed with chromium-potassium alum. T. H. P.

1206. *Variation of Magnetic Susceptibility with Temperature.* II. *Aqueous Solutions.* **A. E. Oxley.** (Cambridge Phil. Soc., Proc. 17. No. 1. pp. 65–89, Feb. 14, 1913.)—The relation between temperature and magnetic susceptibility of aqueous solutions of ferric chloride, ferrous sulphate, and ferric nitrate has been investigated. Assuming the independence of the susceptibility on the intensity of the magnetic field and the formation of molecular complexes which contain water of hydration and have compositions varying with the temperature according to van Laar's theory, the author derives for the susceptibility χ, the formula, $\chi = A/\theta + B + C\theta$, or, for dilute solutions, $\chi = A/\theta + B$, where θ represents the absolute temperature. The susceptibility-temperature curves for the above solutions are approximately hyperbolic and correspond well with the above formulæ. A 2·23-normal ferric chloride solution, which gave results expressed by $\chi = A/\theta + B$, was shown to possess an abnormal constitution, evidence of this being given by abnormal variation of its viscosity with the temperature and by determinations of the molecular depressions of the freezing-point. [See Abstracts Nos. 938, 1109 (1912).]

T. H. P.

1207. *Magnetic Storms and Hysteresis Phenomena.* **J. Bosler.** (Comptes Rendus, 156, pp. 1419–1421, May 5, 1913.)—The hypothesis that variations in earth currents are the cause of magnetic storms is shown to account in a general way for certain simultaneously recorded curves of horizontal force and east-west earth current, if allowance be made for hysteresis effects produced by the magnetic substances within the earth. R. C.

RADIOLOGY AND ELECTROPHYSIOLOGY.

1208. *Hard X-rays.* **F. Dessauer.** (Phys. Zeitschr. 14. pp. 246–247, March 15, 1913.)—The author finds that the hardest X-rays are furnished by the first portion of the discharge of the induction coil, probably owing to the ionisation of the gas being then a minimum. He constructs an apparatus giving hard rays only. It is worked with the high potentials of a transformer, the X-ray tube being in circuit only at the max. potential, and cut out during the rest of the discharge, which is sent through a high resistance. E. E. F.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1209. *Preparation of Barium.* **C. Matignon.** (Comptes Rendus, 156. pp. 1378–1380, May 5, 1913.)—Barium may be prepared conveniently and cheaply by heating at 1200° a mixture of anhydrous baryta (3 mols.) with commercial silicon (1 atom) of a purity of 90 % or upwards. T. H. P.

1210. *Further Applications of Positive Rays to the Study of Chemical Problems.* **J. J. Thomson.** (Cambridge Phil. Soc., Proc. 17. p. 201, April, 1913. Electrician, 70. p. 765, Jan. 24, 1913.)—Two samples of gases obtained from the residues of liquid air are examined. One sample, treated so as to contain the heavier gases, is found on analysis to contain xenon, krypton, and argon. There are no lines on the photograph unaccounted for, hence it is concluded that there are no unknown heavy gases in the atmosphere in quantities comparable with the known gases. The other sample, treated so as to contain the lighter gases, is found to contain helium, neon, and, in addition, a new gas with the atomic weight 22. The relative brightness of the lines for this gas and for neon shows that the amount of the new gas is much smaller than that of neon. The new gas, of atomic weight 3, which this method of analysis has shown to be present in the tube under certain conditions, is also investigated. The gas had occurred sporadically in the tube from the time of the earliest experiments but its appearance could not be controlled. After a long investigation into the source of this gas, it is found that it always occurs in the gases given out by metals when bombarded by kathode rays: a trace of helium is also usually found on the first bombardment. The metals used are Fe, Ni, Zn, Cu, Pb, and Pt. The gas is also given off by calcium carbide. Various experiments illustrate the stability of the gas. [See Abstract No. 1870 (1912).] A. E. G.

1211. *Effect of High Pressures on the Physical and Chemical Behaviour of Solids.* **J. Johnston** and **L. H. Adams.** (Amer. Journ. Sci. 35. pp. 205–253, March, 1913.)—In considering the influence of compression on solid systems, it is necessary to distinguish between the effects of uniform and non-uniform pressure. The former has a comparatively slight effect on the melting-point, which is usually raised by an amount which is seldom greater than 10° and never greater than 30° per 1000 atmos.; its effect on solubility is small and practically negligible compared with the influence of temperature. Uniform pressure tends to further those reactions which are accompanied by decrease of volume, but it does not follow that it will induce these or other reactions, since the occurrence of a reaction depends primarily on its velocity under the prevailing conditions and there is evidence indicating that velocity of reaction is not greatly affected by uniform pressure. The effects of non-uniform pressure are of much greater importance, the melting-point being always lowered and the solubility always raised by amounts many times as great as with uniform pressure. Indeed, on the assumption that permanent deformation of a crystalline aggregate is conditioned by a real local melting at the parts carrying the bulk of the load at any moment, the pressure required to cause melting at ordinary temperatures is found to be well within the bounds of probability. This is regarded as the cause of most of the phenomena occurring when solid systems are compressed. Discussion of the results obtained from the above standpoint leads to the following conclusions:—(1) The compression required to cause crystalline solids to flow or to weld together depends mainly on the melting-point, heat of fusion and density of the substance and the experimental temperature. There is thus a rough parallelism between ease of flow and melting-point, the substances with the highest melting-points being those which at any fixed temperature require the greatest pressure to weld them. (2) In general, compression does not cause crystallisation of a material or the transformation of one form into another; it does so, however, where the other conditions are such that the velocity of transformation is appreciable, and it further causes a partial transformation wherever the conditions are such that partial melting occurs. (3) With uniform pressure a chemical reaction takes place only at the surfaces of contact, so that a small total amount of compound is formed. When, however, the compression is not uniform there is a renewal of the surfaces and the reaction hence proceeds further; such renewal is the result of a direct abrasive action and may also be advanced by a melting and flowing-away of the reaction product, provided its melting pressure is attained. Thus non-uniform compression has precisely the same effect as grinding the reacting substances together. (4) Several of the criteria applied by Spring (1880–1888) to determine the condition of compressed systems are insufficient. For example, nothing is at present known concerning the equilibrium in the solid system, $BaSO_4 + Na_2CO_3 = Na_2SO_4 + BaCO_3$. (5) In the formation of alloys the conditions are the same as those affecting chemical reaction. Where solid solutions are possible, the intimate contact produced by compression favours diffusion, but does not seem to promote the formation of solid solutions in any other way. These considerations serve to harmonise the outstanding discrepancies in the literature dealing with the effects of high pressure on solids. T. H. P.

1212. *Crystallisation of Steel.* **F. Giolitti.** (Accad. Sci. Torino, Atti, 48. 10a. pp. 413–433, 1912–1913.)—The author describes experiments which lead him to take a somewhat different view from that of Belaiew [Abstract No. 1280 (1912)] as to what occurs during the crystallisation of steel. He concludes that there are two successive processes of crystallisation: (1) the formation of mixed crystals of the fused metallic mass, and (2) the segregation of the ferrite or cementite from the solid solution. Contrary to Belaiew's results, slow cooling is found to favour the formation of Widmanstätten's figures in steel containing about 0·82 % carbon and heated to 1000° C. for 8 hours, while rapid cooling renders them less perfect. Belaiew's hypothesis to explain the formation of Widmanstätten's structure and his theory of secondary crystallisation are not accepted. W. H. Si.

1213. *Vacuum-furnace Metallurgy.* **C. G. Fink.** (Amer. Electrochem. Soc., Trans. 21. pp. 445–458; Discussion, pp. 458–461, 1912.)—An account of experiments made since 1907, when cobalt ores had been discovered at Cobalt, in Arsem vacuum furnaces at less than 8 mm. of mercury in the General Electric Research Laboratories at Schenectady and Harrison. Arsenic would also distil over at atmospheric pressure, but silver would be lost then, and the value of the ores depends practically on their silver-contents. The ores, also stibnite, Sb_2S_3, are also heated with additions; of these calcium carbide, produced in the furnace from carbon and calcium carbonate, answers best—better in the case of stibnite than iron. H. B.

1214. *Liquidus Curves and Equilibrium Diagram of the Ternary Series Aluminium-Copper-Zinc (Rich Copper Alloys).* **H. C. H. Carpenter** and **C. A. Edwards.** (Rev. de Métallurgie, 10. pp. 429–450, March, 1913.)—The method of graphically representing the equilibrium of a ternary series by means of a space model has been dealt with, particularly as regards its application to systems in which there is either complete insolubility or partial solubility in the solid. Alloys containing 40 to 100 % Cu, up to 60 % Zn and 16 % Al have been prepared and their cooling and heating curves studied between 400° C. and the point of solidification. The results of the thermal and microscopic examinations have been summed up by the construction of a model built up in sections corresponding to the existence of alloys of similar constitution, *e.g.* α, β, γ, $\alpha+\beta$, and so on. The liquidus shows that there is no ternary compound formed in the area studied and gives no definite indication of the existence of a ternary eutectic. At 700° C. the β constituent appears to undergo a polymorphic change and the $\beta \longrightarrow \alpha+\gamma$ inversion falls in a smooth curve on the Cu-Al side to 470° C. on the Cu-Zn side and at the same time appears to fall off in intensity. Effects of annealing and quenching on the microstructures have been studied and are illustrated by typical photomicrographs. The practical bearing of the results is briefly discussed at the end of the paper. F. C. A. H. L.

1215. *Aluminium Brasses.* **L. Guillet.** (Rev. de Métallurgie, 10. pp. 463–465, March, 1913.)—The author points out that the work on the coefficient of equivalence in special brasses which Carpenter and Edwards [see preceding Abstract] have attributed to Cavalier should have been attributed to him [Abstract No. 1088 (1910)]. The coefficient of equivalence is not so simple a value as was originally thought; for although alloys containing 36 % Zn and 9·4 % Al respectively are microscopically equivalent, the Al alloy has the better mechanical properties. F. C. A. H. L.

1216. *Influence of Other Metals on the β Constituent of Copper-Zinc Alloys.* **H. C. H. Carpenter.** (Rev. de Métallurgie, 10. pp. 457–462, March, 1913.)—The author has previously pointed out [Abstract No. 1457 (1912)] that below 470° C. the β constituent of copper-zinc alloys is to be regarded as a minute complex of $\alpha+\gamma$ particles. For the large, irregularly shaped polyhedra of pronounced reddish-yellow colour occurring in alloys of about 52 % Zn the name "apparent β" is suggested. The effect of an added metal on the inversion may be brought about in several ways: (1) it may be quite or practically insoluble in apparent β (Bi, Pb, Cr) but exert its influence by virtue of great power of crystallisation; (2) it may possess limited solubility (Sb, Sn, Al, V, Si, Fe) and either displace the eutectoid composition towards the γ side or affect the temperature of the inversion, and (3) it may be very or completely soluble (Mn, Ni) and lower the temperature of the inversion to below the ordinary temperature—a highly desirable result, because β would then be the stable phase at ordinary temperatures and the development of brittleness would be prevented. Investigation of the effects of the metals enumerated above has shown that the effects of Bi, Pb, and Cr on the stability of apparent β are so slight as to be negligible for the amounts present in industrial alloys. All the partially soluble metals appear to assist the inversion by displacing the alloy from the eutectoid composition to the γ side. V, Si, Sn, Sb, and Al are particularly active in this respect, while Fe is least active on account of its lowest solubility. Ni is somewhat irregular in action, but generally aids the $\alpha+\gamma$ separation, while

Mn is almost without action. Heating- and cooling-curves of alloys containing approximately 3 % of Cr, Fe, and Mn respectively show that the temperature of the inversion is practically unaffected. From the practical point of view, the results show that it is impossible to prevent the inversion by the addition of a third element, but, on the other hand, the stability of the β structure is increased by the removal of impurities as far as possible.

F. C. A. H. L.

1217. *Chemical Properties and Relative Activities of the Radio-products of Thorium.* **H. N. McCoy** and **C. H. Viol.** (Phil. Mag. 25. pp. 333–359, March, 1913.)—The paper gives results of a large number of experiments on the chemical reactions of all the longer-lived radio-active products of thorium. From a knowledge of the chemical properties methods are worked out for the separation of the various products from inactive substances and from one another, and for the preparation of several of the products completely free from radio-active impurities. The relative activities of Th(B + C + D) and Th(X + Em + A) was determined by preparing ThX entirely free from B + C + D and determining its change of activity with time. Knowing the periods of each of the substances the α-ray activity of B + C + D was found to be 0·427 of that of X + Em + A. Similarly it was found that the products of radio-thorium are 5·23 times as active as the Radio-Th itself. These ratios are in good agreement with those calculated on the assumption that the total ionisation of an α-particle is proportional to the 2/3 power of its range. The periods of ThX, ThB, and ThC were found to be 3·64 days, 10·60 hours, and 60·8 mins. respectively.

E. M.

1218. *Spontaneous Variations of Concentration.* **E. v. Schweidler.** (Phys. Zeitschr. 14. pp. 198–200, March 1, 1913.)—Attributes the deviations of Svedberg's observed variations of concentration in radio-active solutions [Abstract No. 730 (1913)] from the values predicted by Langevin, Smoluchowski, and Lorentz, to some disturbance affecting many atoms simultaneously, as when swarms of radio-active atoms adhering to adsorption nuclei moving through the solution enter the "effective area" in an irregular manner, or when in a gas containing emanation a rapidly changing distribution of the radio-active deposit is brought about by irregularly varying electric fields. The actually observed values do not exceed the theoretical values by more than 43 per cent.

E. E. F.

1219. *Energy Absorbed and the Amount of Reaction Taking Place in a Photochemical Reaction.* **M. Boll.** (Comptes Rendus, 156. pp. 691–694, March 3, 1913.)—A trough, with a quartz bottom and containing a solution of chloroplatinic acid, is placed in the path of a ray of monochromatic light ($\lambda = 2536$) falling on another trough, also containing a solution of chloroplatinic acid. The amount of photochemical action which takes place in each solution can be determined by measuring the electrical conductivities of the solutions [see Abstract No. 769 (1912)]. The amount of reaction taking place in the lower trough is a measure of the light which has come through the upper trough and therefore of the light absorbed in the upper trough. The amount of reaction in the upper trough is known from the electrometric measurements, and therefore the photochemical action of the light absorbed can be determined. It is found that when the same solution is both absorbing light and undergoing a chemical reaction, the energy of the emergent light decreases in accordance with the laws of Lambert and Beer; that is, it is an exponential function of the thickness of the absorbing layer and of the concentration. There is, however, no proportionality between the amount of reaction taking place and the energy absorbed, as there should be according to the law of Grotthus ; the amount of reaction is extremely small, even when the amount of energy absorbed is relatively considerable. T. S. P.

1220. *Ionic Size in Relation to Molecular Physics, together with a New Law relating to the Heats of Formation of Solid, Liquid, and Ionic Molecules.* **W. R. Bousfield.** (Roy. Soc., Proc. Ser. A. 88. pp. 147–169, March 31, 1913.)—In a former paper it was shown that ionic volumes (derived from mobilities) and solution volumes were connected by an empirical linear relation $EV_r = a - bI_v$. In the present paper a new empirical relation is established of the form $D^{-1} = p - qN(I_v - K)$, where D is the effective molecular freezing-point depression, *i.e.* $\Delta/N(1+a)$. In the former paper the experimental data were given for KCl and NaCl, and in the present paper for LiCl, which data determine the constants *a*, *b*, *p*, *q*, for each salt. It is shown that we can express in terms of these constants—(1) The factor required to reduce arbitrary ionic volume units to absolute units ; (2) the volume of the ionic nuclei ; (3) the volume and mean density of the "watery atmospheres" associated with the ions. It is shown for a group of fourteen solid and liquid salts and acids that their heats of formation are given by the expression $\frac{7}{8}\delta V + H_1 + H_2$, where δV is the reduction of volume (or contraction) which takes place on combination, and H_1 and H_2 are constants for the elements of which they are composed. It is found that the heats of ionisation of the three salts may also be expressed under the same law as

$$\Sigma\tfrac{7}{8}\delta V + H_1 + H_2 + 1{\cdot}3n - 29$$

where δV includes volume-change of combined water as well as of ionic nuclei, *n* is number of molecules of combined water and -29 is a constant which represents endothermic changes involved in ionisation. T. M. L.

1212. *Conductivity, Dissociation and Temperature-coefficients of Conductivity of Salts, as Conditioned by Temperature, Dilution, Hydration and Hydrolysis.* **E. J. Shaeffer** and **H. C. Jones.** (Amer. Chem. Journ. 49. pp. 207–258, March, 1913.)—Conductivity increases with temperature and dilution. As a rule temperature-coefficients in conductivity units increase with rise in temperature. Salts strongly hydrated have large coefficients, those not strongly hydrated have small coefficients. The temperature-coefficients are of the same order of magnitude for salts having approximately the same hydrating power. They increase with dilution, and the increase is greatest for those substances with large hydrating power. With but one exception dissociation was found to decrease with rise in temperature. Temperature coefficients in per cent. decrease with rise in temperature. T. M. L.

1222. *Normal and Abnormal Cases of Specific Volume of Binary Liquid Mixtures.* **H. S. Van Klooster.** (Amer. Chem. Soc., Journ. 35. pp. 145–150, Feb., 1913.)—The specific volume data for mixtures of paranitrotoluene and carbon disulphide are not really abnormal if calculated for an extrapolated value for the specific volume of (strongly-undercooled) liquid paranitrotoluene. The max. deviation between the observed and calculated specific volume is then only 0·003, being rather less than the max. difference for mixtures of carbon disulphide and chloroform. A real abnormality is found in mixtures of chloroform and ether, which appear to form a compound $CHCl_3 + C_4H_{10}O$. This is indicated by a max. contraction and rise of temperature on mixing, as well as by abnormal viscosity curves. T. M. L.

1223. *Slow Ions in Liquid Dielectrics.* **H. J. van der Bijl.** (Deutsch. Phys. Gesell., Verh. 15. 4. pp. 102–108, Feb. 28, 1918.)—The author discusses the formulæ for the motion of ions in very viscous media, with special reference to ions produced by radium rays and by ultra-violet light, in vaseline and in aniline. T. M. L.

1224. *Galvanic Cells of Water-insoluble Organic Liquids and Aqueous Solutions.* **R. Beutner.** (Amer. Chem. Soc., Journ. 35. pp. 344–352, April, 1913.)—Preliminary communication on a new kind of e.m.f. The concentration cell: —Ag | $AgNO_3$ diluted . . . $AgNO_3$ concentrated | Ag+ may also be arranged +$AgNO_3$ dil. | Ag | $AgNO_3$ conc.—. J. Loeb and the author found that animal and vegetable skins behaved like metals in the latter type of cell; and the author now states that certain organic substances insoluble in water act similarly. Thus the combination —*m*/10NaCl | salicylic aldehyde | *m*/1250 NaCl+ yields 0·075 volt. The cell is therefore reversible for the Na-ion; but the reversibility is not confined to this Na-ion (as it would be to the Ag-ion in the ordinary case), for the NaCl may be replaced by KCl, $CaCl_2$, Na_2SO_4, $CuSO_4$, NH_4Cl, $AlCl_3$, etc. Explaining the phenomena on Nernst's lines, the author considers that the solution should contain a strong acid (salicylic) likely to react with the salt KCl, and that the concentration of the resulting K-salicylate should be greater than the concentration of KCl in water. Similarly aniline should behave like a chlorine-electrode; and this is found to be the case. The phenomena appear important for the e.m.f. of living tissues, the migration of small particles through membranes and narrow tubes and the precipitating action of salts on colloids. H. B.

1225. *Electro-osmotic Potential-differences caused by the Movement of Solid Particles in Liquids.* **J. Stock.** (Acad. Sci. Cracovie, Bull. 3a. pp. 131–144, March, 1913.)—The apparatus used consisted of a 200 cm. long glass tube of 1·5 sq. cm. area. In the tube were five small side-tubes, into which were sealed Pt-wires in such a way that they could not come into contact with quartz powder falling through the liquid (nitro-benzene) contained in the tube. The two outer electrodes were connected with a sensitive Deprez-d'Arsonval galvanometer, so that the relative conductivity of the liquid for different quantities of quartz powder could be determined directly, a potential of 120 volts being used in order to diminish as much as possible the error due to polarisation. The three intermediate electrodes were connected in pairs with the one set of quadrants of a Dolezalek electrometer, and to earth, and served for the potential measurements. The other pair of quadrants were earthed; the potential applied to the needle was 20–100 volts. The whole tube could be turned through any angle round a horizontal axis fixed in the wall; it was covered with wire gauze, which was earthed, in order to do away with electrostatic disturbances. The author develops the theory of Smoluchowski for the phenomenon in question to meet the case of the particular experimental method used and finds an agreement between theory and experiment. From the results he is enabled to calculate the p.d. occurring in the electrical double layer, and also the thickness of the layer, the values being 0·053 volt and $4·5 \times 10^{-7}$ cm. respectively, which values are in agreement with those previously found by the author [Abstract No. 498 (1913)]. T. S. P

1226. *Prevention of Iron Corrosion by Counter E.M.F.* **J. K. Clement** and **L. V. Walker.** (Amer. Electrochem. Soc., Trans. 22. pp. 198–208; Discussion, p. 208, 1912.)—The experiments were made at the Pittsburg station of the Bureau of Mines. Couples of iron and carbon are immersed in dilute sulphuric acid and currents from accumulators passed from the carbon to the iron. These currents prevent the formation of ferrous ions; the corrosion is much accelerated by passing oxygen through the electrolyte, which prevents the polarisation by hydrogen, and by stirring. The supply of hydrogen by the current should be equivalent to the oxygen supply near the kathode; the current density required for this purpose can be calculated from the loss of the unprotected iron under the same conditions. H. B

1227. *Corrosion of Iron by Sulphuric Acid in Presence of Other Substances.* **O. P. Watts.** (Amer. Electrochem. Soc., Trans. 21. pp. 337–353; Discussion, pp. 353–358, 1912. Electrician, 71. pp. 560–562, July 11, 1913.)—The rate of corrosion of iron in sulphuric acid—important for the pickling process—is strongly influenced by the presence of other substances. Arsenic and tin, also chromium and mercury, retard the corrosion, which effect is ascribed to overvoltage. A retarding influence is also exercised by hydrochloric acid, alkali chlorides, etc. Chromic acid, dichromates (!), nitrates, copper sulphate, on the other hand, are said to accelerate corrosion. The experiments are preliminary, and much evidently depends, as was pointed out by **A. S. Cushman, E. B. Spear,** and **W. A. Patrick,** on the relative concentrations, also as regards the protection afforded by arsenic. H. B.

1228. *Influence of Various Elements on the Corrodibility of Iron.* **C. F. Burgess** and **J. Aston.** (Amer. Electrochem. Soc., Trans. 22. pp. 241–250; Discussion, pp. 251–258, 1912.)—The effect of small proportions of various elements on the corrodibility of electrolytic iron was investigated by exposing strips of the metals to the action of (1) weather conditions for 162 days, and (2) 20 per cent. sulphuric acid for one hour. The great majority of the alloys exhibit greater durability than the electrolytic iron, thus refuting the popular belief that any element added to iron increases its corrodibility by furnishing galvanic couples. Certain forms of pure commercial iron are also less corrodible than electrolytic iron. Aluminium has little influence on the liability of iron to corrode, and there is no particular merit in the use of arsenic alloys in this respect; further, As produces brittleness and weakness and also high magnetic qualities, but is difficult to add. Cobalt diminishes corrosion, but has no advantage over the cheaper nickel. Addition of copper results in marked decrease of the rate of attack of iron by acid, and possibly by atmospheric conditions; this effect may be due to the solution of iron and formation of a film of copper, which protects the underlying metal. Corrosion by acid is apparently unchanged by the presence of lead (0·061 per cent.) whilst atmospheric corrosion seems to be retarded.

With manganese (0·5–10·42 per cent.) the results obtained are inconsistent, but the atmospheric tests appear to indicate slight increase of corrosion with increase of Mn-content, though in all cases the corrosion is less than for electrolytic iron alone. Nickel gives good results in both the acid and atmospheric tests, there being a general tendency for increased resistance with increased proportion of Ni. The highest resistance found is with 10 per cent. or more of Ni; but such alloys are not generally applicable in practice, owing to their cost and undesirable physical properties. An alloy containing 0·017 per cent. of selenium exhibits low resistance to corrosion either by acid or in the air.

The addition of silicon in the usual proportions seems to be disadvantageous both to acid and to atmospheric corrosion. With silver (0·28–0·69 per cent.) the results are closely compared with those obtained with the iron alone. With alloys containing tin (0·28–1·56 per cent.) the resistance towards acid is particularly good with small proportions of tin, but shows marked increase with larger proportions; the atmospheric tests show nothing particularly noteworthy. Addition of tungsten (0·4–28·86 per cent.) gives good, but irregular, results in the acid tests; the same is true in regard to the atmospheric tests, in which an apparent tendency towards decreased corrosion with increased tungsten content is observed. T. H. P.

1229. *Inclusions in Electrolytic Silver and their Effect on the Electrochemical Equivalent of Silver.* **J. S. Laird** and **G. A. Hulett.** (Amer. Electrochem. Soc., Trans. **22.** pp. 345–365; Discussion, p. 365, 1912.)—After a discussion of the various attempts which have been made to determine the amount of inclusions, if any, in electrolytic silver, the authors describe a new method which they have adopted. It consists in dissolving the electrolytic silver in molten tin at 400°–500°; at these temperatures tin is readily oxidised, not only taking up oxygen rapidly and completely, but also reducing oxides of nitrogen to nitrogen. It also decomposes silver nitrate, the silver and oxygen being retained and the nitrogen liberated quantitatively. The quantities of gases evolved are small and require a special method of analysis, the one adopted being that of fractional condensation at low temperatures. Any gas remaining uncondensed consists of nitrogen, which can only have come from the decomposition of silver nitrate, and is therefore taken as a measure of the silver nitrate originally present in the silver crystals. Any other gases which would be likely to occur would be oxidised to water-vapour and CO_2 and condensed. The results showed that the deposits on gold cups contained slightly less water than the deposits on platinum cups, but that the other impurities were considerably greater in the deposits on gold. The average amounts of impurities per gm. of silver deposited were of the order: 0·042 gm. of water, 0·0042 gm. of CO_2, and 0·0053 gm. of silver nitrate. The CO_2 is due probably to some colloidal silver compound, possibly silver carbonate, which is present in the supposedly pure silver nitrate. The results show that silver deposited from the purest silver nitrate solution, kept free from filter paper or anode liquor, contains at least 5 parts in 100,000 of impurity, and may contain several times this amount in deposits formed in the Rayleigh coulombmeter. [See Abstract No. 1017 (1908).] T. S. P.

1230. *Electrochemical Equivalent of Cadmium.* **J. S. Laird** and **G. A. Hulett.** (Amer. Electrochem. Soc., Trans. **22.** pp. 385–393; Discussion, pp. 393–396, 1912.)—Comparison of the masses of different ions liberated from solution by the passage of the same quantity of electricity would be, theoretically at least, the simplest and most direct method of comparing equivalent weights. Such a comparison has been made in very few cases with any degree of accuracy, mainly on account of two difficulties: (1) The solution of a metal in contact with the metal often contains two or more kinds of kathions, all of which assist in carrying the current; (2) in most cases it is difficult to obtain a deposit which is pure and capable of being freed from the electrolyte without loss or oxidation in washing. These difficulties can be obviated by using a cadmium salt (the sulphate) and depositing the Cd at a mercury kathode contained in an amalgamated Pt cup [compare

Hulett and Perdue, Abstract No. 816 (1911)]. Under these conditions, using an apparatus so designed that anolyte and katholyte are prevented from mixing, the authors find 112·81 ± 0·01 as the atomic weight of Cd. This degree of accuracy has not been previously attained with any form of coulombmeter except the silver coulombmeter, using silver nitrate as electrolyte. T. S. P.

1231. *Electrolysis of Crystalline Compounds.* I. *Silver Iodide.* **G. Bruni** and **G. Scarpa.** (Accad. Lincei, Atti, 22. pp. 438–443, April 6, 1913.)—Experiments on the electrolysis of AgI at temperatures between 160° and 400° C. using silver electrodes about 2 mm. thick, inserted in the fused electrolyte, and a current of 0·1 amp., show that the quantity of Ag passing from the anode to the kathode obeys Faraday's law. It is concluded that any metallic conductivity possessed by the iodide cannot be more than a very small fraction of the total conductivity. W. H. Si.

1232. *Co-precipitation of Copper and Carbon by Electrolysis.* **E. B. Spear, C. Chow,** and **A. L. Chesley.** (Amer. Electrochem. Soc., Trans. 22. pp. 277–280, 1912.)—It is shown that when solutions of copper sulphate, containing nitric acid and varying quantities of gelatine, are electrolysed, using a rotating kathode and current densities varying from 8·6 to 10 amps./dm.^{2}, carbon can be precipitated with copper at the kathode. The evidence indicates that at least some of the carbon is in a free state in the deposit. The authors conclude that an oxidising action, due to secondary reactions, takes place at the kathode. [Compare Abstract No. 290 (1910).] T. S. P.

1233. *Effect of Addition Substances in Lead Plating Baths.* **F. C. Mathers** and **O. R. Overman.** (Amer. Electrochem. Soc., Trans. 21. pp. 313–332; Discussion, pp. 332–335, 1912.)—This paper gives the results of experiments to find the best addition substances for use in lead plating and refining baths. The following classes of compounds were tried: Inorganic, essential oils, resins and gums, sugars and starches, alkaloids and their derivatives, glucosides, proteids and nitrogenous animal substances, ferments and enzymes, phenols and miscellaneous substances. Some compounds in all organic classes showed marked beneficial action, but most of them were without any such effect. All the effective addition agents contain the hydroxyl group, but this relationship is too general to be of any value. The addition substances which are of value, arranged in the order of their beneficial action, are clove oil or eugenol, peptone, phloridzin, and gum guaiac. Clove oil is recommended for use in lead perchlorate plating and refining baths; about ½ lb. is required per ton of lead. Phloridzin is, perhaps, a slightly more satisfactory addition substance, but its cost is prohibitive. In an appendix a method is given for the convenient preparation of perchloric acid. T. S. P.

1234. *Hundred-volume Index to the "Chemical News,"* 1860–1909. (712 pp., London, 1913.)—A combined subject and authors' index, alphabetically arranged, pertaining not only to the original communications published therein, but also to the reviews of books and the abstracts from other sources. L. H. W.